PREFACE

INASMUCH as Sir W. H. Flower and Mr. Lydekker could not profess to treat the Mammalia exhaustively within the limits of nearly 800 pages, in their *Introduction to the Study of Mammals,* it is obvious that the present volume, which appears ten years later and is of rather less size, can contain but a selection of the enormous mass of facts at the disposal of the student of this group. Thus the chief question for myself was what to select and what to leave aside. It will be observed that I have reduced the pages of this book to conformity with those of other volumes of the series by treating some groups more briefly than others. It has appeared to me to be desirable to treat fully such groups as the Edentata and the Marsupialia, and permissible to be more brief in dealing with such huge Orders as those of the Rodentia and Chiroptera. Lengthy disquisitions upon such familiar and comparatively uninteresting animals as the Lion and Leopard have been curtailed, and the space thus saved has been devoted to shorter and more numerous accounts of other creatures. As there are nearly six hundred genera of living Mammals known to science, omission as well as compression became an absolute necessity. I have given, I hope, adequate treatment from the standpoint of a necessarily limited treatise to the majority of the more important genera of Mammals both living and extinct; but the length of this part of the book had to be increased for the discoveries, which give me at once an advantage and a disadvantage as compared with the two authors whose names I have quoted, of a considerable number of important new types [illegible] last ten years.

Such forms as *Notoryctes*, *Romerolagus*, *Caenolestes*, "*Neomylodon*," and *Ocapia* could not possibly have been omitted.

In preparing my accounts of both living and extinct forms I have nearly invariably consulted the original authorities, and have often supplemented or verified these accounts by my own dissections at the Zoological Society's Gardens. My rule has not, however, been invariable in this matter, inasmuch as there exist two recent and trustworthy text-books of Mammalian Palaeontology —Professor Zittel's *Handbuch der Palaeontologie*, and Dr. A. Smith Woodward's manual, *Outlines of Vertebrate Palaeontology*, in the Cambridge Biological Series. Where the name of a genus only or its range, or merely one or two facts about it, are mentioned, I have not thought it necessary to go further than these two works. But a good deal has been done even since the appearance of these two volumes which it will be found that I have not ignored.

I have to thank my editors for the trouble which they have taken in the revision of the proofs and for many suggestions. To Professor Osborn, of Columbia University, New York, I am indebted for some kind suggestions. My daughter Iris has assisted me in various ways. Finally, I desire to express my indebtedness to Mr. Dixon and to Mr. M. P. Parker for the care which they have taken in the preparation of the figures which were drawn by them especially for this work.

FRANK E. BEDDARD.

LONDON, *February* 28, 1902.

CONTENTS

CHAPTER VIII

CHAPTER IX

CHAPTER X

CHAPTER XI

CHAPTER XII

CHAPTER XIII

CHAPTER XIV

CHAPTER XV

CHAPTER XVI

CHAPTER XVII

SCHEME OF THE CLASSIFICATION ADOPTED IN THIS BOOK

Sub-Class **PROTOTHERIA** (p. 105).

Order.	Sub-Order	Family	Sub-Family.
MONOTREMATA (p. 106)		ECHIDNIDAE (p. 110).	
		ORNITHORHYNCHIDAE (p. 112).	
?**ALLOTHERIA** (p. 96).			

Sub-Class **EUTHERIA** (p. 116).

Order.	Sub-Order	Family	Sub-Family.
MARSUPIALIA (p. 122)	**Diprotodontia** (p. 128)	MACROPODIDAE (p. 129)	Macropodinae (p. 132).
			Potoroinae (p. 137).
			Hypsiprymnodontinae (p. 138).
		PHALANGERIDAE (p. 138)	Phalangerinae (p. 140).
			Phascolarctinae (p. 142).
			Phascolomyinae (p. 144).
			Tarsipedinae (p. 145).
		EPANORTHIDAE (p. 145).	
	Polyprotodontia (p. 149)	DASYURIDAE (p. 149).	
		DIDELPHYIDAE (p. 155)	
		PERAMELIDAE (p. 156).	
		NOTORYCTIDAE (p. 158).	
EDENTATA (p. 161)	**Xenarthra** (p. 166)	MYRMECOPHAGIDAE (p. 166).	
		BRADYPODIDAE (p. 170).	
		DASYPODIDAE (p. 173).	
		MYLODONTIDAE (p. 179).	
		MEGALONYCHIDAE (p. 183).	
		MEGATHERIIDAE (p. 183).	
		GLYPTODONTIDAE (p. 184).	
	Nomarthra (p. 186)	ORYCTEROPODIDAE (p. 187).	
		MANIDAE (p. 188).	
GANODONTA (p. 190)		STYLINODONTIDAE (p. 191).	
		CONORYCTIDAE (p. 193).	

Order.	Sub-Order	Family.	Sub-Family.
UNGULATA (p. 195)	**Condylarthra** (p. 202).		
	Amblypoda (p. 205)		
	Ancylopoda (p. 211).		
	Typotheria (p. 212).		
	Toxodontia (p 214).		
	Proboscidea (p. 216)	ELEPHANTIDAE (p. 217).	
		DINOTHERIIDAE (p. 231).	
	Hyracoidea (p. 232).		
	Perisso-dactyla (p. 235)	EQUIDAE (p. 237).	
		LOPHIODONTIDAE (p. 247).	
		PALAEOTHERIIDAE (p. 247).	
		TAPIRIDAE (p. 250).	
		RHINOCEROTIDAE (p. 253).	
		TITANOTHERIIDAE (p. 264).	
	Litopterna (p. 267)	MACRAUCHENIIDAE (p. 267).	
	Artiodactyla (p. 269)	HIPPOPOTAMIDAE (p. 273).	
		SUIDAE (p. 275).	
		DICOTYLIDAE (p. 278).	
		TRAGULIDAE (p. 282).	
		PROCERATIDAE (p. 284).	
		CAMELIDAE (p. 285).	
		CERVIDAE (p. 291)	Cervinae (p. 293).
			Moschinae (p. 299).
		GIRAFFIDAE (p. 301).	
		ANTILOCAPRIDAE (p. 306).	
		BOVIDAE (p. 307)	
		ANTHRACOTHERIIDAE (p. 328).	
		CAENOTHERIIDAE (p. 329).	
		XIPHODONTIDAE (p. 329).	
		OREODONTIDAE (p. 330).	
		ANOPLOTHERIIDAE (p. 332).	
SIRENIA (p. 333).			
CETACEA (p. 339)	**Mystacoceti** (p. 353)	BALAENOPTERIDAE (p. 355).	
		BALAENIDAE (p. 358).	
	Odontoceti (p. 362)	PHYSETERIDAE (p. 362)	Physeterinae (p. 363).
			Ziphiinae (p. 367).
		DELPHINIDAE (p. 372).	
		PLATANISTIDAE (p. 380).	
		SQUALODONTIDAE (p. 384).	
	Archaeoceti (p. 384)	ZEUGLODONTIDAE (p. 384).	
CARNIVORA (p. 386)	**Fissipedia** (p. 387)	FELIDAE (p. 390).	
		MACHAERODONTIDAE (p. 401).	
		VIVERRIDAE (p. 403)	Euplerinae (p. 403).
			Galidictiinae (p. 404).
			Cryptoproctinae (p. 404).
			Viverrinae (p. 405).
			Herpestinae (p. 409).

Order.	Sub-Order	Family.	Sub-Family.
CARNIVORA (*Continued*)	**Fissipedia** (*Continued*)	HYAENIDAE (p. 411).	
		CANIDAE (p. 413).	
		PROCYONIDAE (p. 426).	
		MUSTELIDAE (p. 431)	Melinae (p. 432).
			Mustelinae (p. 433).
			Lutrinae (p. 439).
		URSIDAE (p. 442).	
	Pinnipedia (p. 446)	OTARIIDAE (p. 450).	
		TRICHECHIDAE (p. 451).	
		PHOCIDAE (p. 452).	
'**CREODONTA** (p. 455).			
RODENTIA (p. 458)	**Simpliciden-tata** (p. 462)	ANOMALURIDAE (p. 462).	
		SCIURIDAE (p. 463).	
		CASTORIDAE (p. 467).	
		HAPLODONTIDAE (p. 469).	
		GLIRIDAE (p. 470).	
		MURIDAE (p. 471)	Murinae (p. 471).
			Phlaeomyinae (p. 473).
			Hydromyinae (p. 474).
			Rhynchomyinae (p. 474).
			Gerbillinae (p. 475).
			Otomyinae (p. 475).
			Dendromyinae (p. 476).
			Lophiomyinae (p. 476).
			Microtinae (p. 477).
			Sigmodontinae (p. 479).
			Neotominae (p. 480).
		BATHYERGIDAE (p. 480).	
		SPALACIDAE (p. 482).	
		GEOMYIDAE (p. 483).	
		HETEROMYIDAE (p. 484).	
		DIPODIDAE (p. 484).	
		PEDETIDAE (p. 486).	
		OCTODONTIDAE (p. 487)	Octodontinae (p. 487).
			Loncherinae (p. 488).
			Capromyinae (p. 489).
		CTENODACTYLIDAE (p 490).	
		CAVIIDAE (p 491).	
		DASYPROCTIDAE (p. 493).	
		DINOMYIDAE (p. 495).	
		CHINCHILLIDAE (p. 496).	
		CERCOLABIDAE (p. 497).	
		HYSTRICIDAE (p 499).	
	Dupliciden-tata (p. 502)	LEPORIDAE (p. 502).	
		LAGOMYIDAE (p. 505).	
TILLODONTIA (p. 506).			
INSECTIVORA (p. 508)	**Insectivora Vera** (p. 509)	ERINACEIDAE (p. 509).	
		TUPAIIDAE (p. 511).	
		CENTETIDAE (p. 511).	
		POTAMOGALIDAE (p. 513).	
		SOLENODONTIDAE (p. 513).	
		CHRYSOCHLORIDAE (p. 514).	
		MACROSCELIDAE (p. 515).	
		TALPIDAE (p. 516).	
		SORICIDAE (p. 518).	
	Dermoptera (p. 520)	GALEOPITHECIDAE (p. 520).	

SCHEME OF CLASSIFICATION

	Sub-Order.	Family	Sub-Family.
CHIROPTERA p. 521	**Megachiroptera** (p. 524)	PTEROPODIDAE (p. 524).	
	Microchiroptera (p. 526)	RHINOLOPHIDAE (p. 527).	
		NYCTERIDAE (p. 527).	
		VESPERTILIONIDAE (p. 528).	
		EMBALLONURIDAE (p. 530).	
		PHYLLOSTOMATIDAE (p. 531).	
PRIMATES p. 533)	**Lemuroidea** (p. 534)	LEMURIDAE (p. 538)	Indrisinae (p. 538).
			Lemurinae (p. 540).
			Galagininae (p. 542).
			Lorisinae (p. 545).
		CHIROMYIDAE (p. 548).	
		TARSIIDAE (p. 550).	
		ANAPTOMORPHIDAE (p. 552).	
		CHRIACIDAE (p. 552).	
		MEGALADAPIDIDAE (p. 554).	
	Anthropoidea (p. 554)	HAPALIDAE (p. 556)	
		CEBIDAE (p. 557).	
		CERCOPITHECIDAE (p. 562).	
		SIMIIDAE (p. 570)	
		HOMINIDAE (p. 585)	

CHAPTER I

INTRODUCTORY

THE Mammalia form a group of vertebrated animals which roughly correspond with what are termed in popular language "quadrupeds," or with the still more vernacular terms of "beasts" or "animals." The name "Mammal" is derived from the most salient characteristic of the group, *i.e.* the possession of teats; but if the term were used in an absolutely strict etymological sense, it could not include the Monotremes, which, though they have mammary glands, have not fully-differentiated teats (see p. 16). There are, however, as will be seen shortly, other characters which necessitate the inclusion of these egg-laying quadrupeds within the class Mammalia.

The Mammalia are unquestionably the highest of the Vertebrata. This statement, however, though generally acceptable, needs some explanation and justification. "Highest" implies perfection, or, at any rate, relative perfection. It might be said with perfect truth that a serpent is in its way an example of perfection of structure: not incommoded with limbs it can slip rapidly through the grass, swim like a fish, climb like a monkey, and dart upon its prey with rapidity and accuracy. It is an example of an extremely specialised reptile, the loss of the limbs being the most obvious way in which it is specialised from more generalised reptilian types. Specialisation in fact is often synonymous with degradation, and, this being the case, implies a restricted life. On the other hand, simplification is not always to be read as degeneration. The lower jaw, for instance, of mammals has fewer bones in it than that of reptiles, and is more concisely articulated to the skull; this implies greater efficiency

as a biting organ. The term highest, however, includes increased complexity as well as simplification, the two series of modifications being interwoven to form a more efficient organism. It cannot be doubted that the increased complexity of the brain of mammals raises them in the scale, as does also the complex and delicately adjusted series of bonelets which form the organ for the transmission of sound to the internal ear. The separation of the cavity containing the lungs, and the investment of the partition so formed with muscular fibres, renders the action of the lungs more effective; and there are other instances among the Mammalia of greater complexity of the various parts and organs of the body when compared with lower forms, which help to justify the term "highest" generally applied to these creatures.

Complexity and finish of structure are often accompanied by large size; and the Mammalia are, on the whole, larger than any other Vertebrates, and also contain the most colossal species. The huge Dinosaurs of the Mesozoic epoch, though among the largest of animals, are exceeded by the Whales; and the latter group includes the mightiest creature that exists or has ever existed, the eighty-five-feet-long Sibbald's Rorqual. Confining ourselves rigidly to facts, and avoiding all theorising on the possible relation between complexity and nicety of build and the capacity for increase in bulk, it is plain from the history of more than one group of mammals that increase in bulk accompanies specialisation of structure. The huge Dinocerata when compared with the ancestral *Pantolambda* teach us this, as do many similar examples. Within the mammalian group, as in the case of other Vertebrates, difference of size has a certain rough correspondence with difference of habitat. The Whales not only contain the largest of animals, but their average size is great; so too with the equally aquatic Sirenia and very aquatic Pinnipedia. Here the support offered by the water and the consequent decreased need for muscular power to neutralise the effects of gravity permit of an increase in bulk. Purely terrestrial animals come next; and finally arboreal, and, still more, "flying" mammals are of small size, since the maintenance of the position when moving and feeding needs enormous muscular effort.

The Mammals are more easily to be separated from the Vertebrates lying lower in the series than any of the latter are from each other in ascending order. A large number of char-

acters might be used in addition to those which will be made use of in the following brief catalogue of essential mammalian features, were it not for the low-placed Monotremata on the one hand and the highly specialised Whales on the other. Including those forms, the Mammalia are to be distinguished from all other Vertebrates by the following series of structural features, which will be expanded later into a short disquisition upon the general structure of the Mammalia. The class Mammalia may, in fact, be thus defined:—

Hair-clad Vertebrates, with cutaneous glands in the female, secreting milk for the nourishment of the young. Skull without prefrontal, postfrontal, quadrato-jugal, and some other bones, and with two occipital condyles formed entirely by the exoccipitals. Lower jaw composed of dentary bone only, articulating only with the squamosal. Ear bones a chain of three or four separate bonelets Cervical vertebrae sharply distinguished from the dorsals, and if with free ribs, showing no transition between these and the thoracic ribs. Brain with four optic lobes. Lungs and heart separated from abdominal cavity by a muscular diaphragm. Heart with a single left aortic arch. Red blood-corpuscles non-nucleate.

The following characters are also very nearly universal, and in any case absolutely distinctive:—Cervical vertebrae, seven; vertebrae with epiphyses. Ankle-joint "cruro-tarsal," *i.e.* between the leg and the ankle, and not in the middle of the ankle.[1] Attachment of the pelvis to the vertebral column pre-acetabular in position.

The Mammalia since they are hot-blooded creatures are more independent of temperature than reptiles; they are thus found spread over a wider area of the earth's surface. As however, though hot-blooded, they have not the powers of locomotion possessed by birds, they are not quite so widely distributed as are those animals. The Mammalia range up into the extreme north, but, excepting only forms mainly aquatic, such as the Sea Lions, are not known to occur on the Antarctic continent. With the exception of the flying Bats, indigenous mammals are totally absent from New Zealand; and it seems to be doubtful whether those supposed oceanic islands which have a mammalian fauna are really

[1] The degeneration of the hind-limb in Whales and Sirenia forbids the use of this character as a distinctive one on the principles advocated by the selection of the above list. But it would be absurd to leave out hair.

oceanic in origin. The continents and oceans are peopled by rather over three thousand species of Mammalia, a number which is considerably less than that of either birds or reptiles. It seems clear that, so far at any rate as concerns the numbers of families and genera, the mammalian fauna of to-day is less varied than it was during the Mid-tertiary period, the heyday of mammalian life. It is rather remarkable to contrast in this way the mammals and the birds. The two classes of the animal kingdom seem to have come into being at about the same period; but the birds either have reached their culminating point to-day, or have not yet reached it. The Mammalia, on the other hand, multiplied to an extraordinary extent during the Eocene and the Miocene periods, and have since dwindled. The break is most marked at the close of the Pleistocene, and may be in part due to the direct influence of man. At present man exercises so enormous an effect, both directly and indirectly, that the future history of the Mammalia is probably foreshadowed by the instances of the White Rhinoceros and the Quagga. On the other hand, the economic usefulness of the Mammalia is greater than that of any other animals; and the next most important era in their history will be probably that of domesticity and "preservation."

CHAPTER II

STRUCTURE AND PRESENT DISTRIBUTION OF THE MAMMALIA

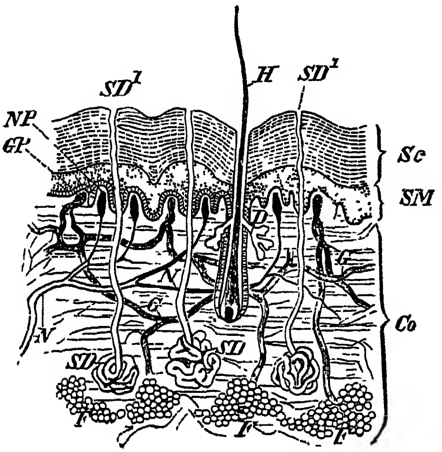
External Form.—It would be quite impossible for any one to confuse any other quadrupedal animal with a mammal. The body of a reptile is, as it were, slung between its limbs, like the body of an eighteenth century chariot between its four wheels; in the mammal the body is raised entirely above, and is supported by, the four limbs. The axes of these limbs too, as a general rule, are parallel with the vertical axis of the body of their possessor. There is thus a greater perfection of the relations of the limbs to the trunk from the point of view of a terrestrial creature, which has to use those limbs for rapid movement. The same perfection in these relations is to be seen, it should be observed, in such running forms among the lower Vertebrata as the Birds and the Dinosaurs, where the actual angulation of the limbs is as in the purely running Mammalia. These relations are of course absolutely lost in the aquatic Cetacea, and not marked in various burrowing creatures. The way in which the fore- and hind-limbs are angulated is considerably different in the two cases. In the latter, which are most used and, as it were, push on the anterior part of the body, the femur has its lower end directed forwards, the tibia and the fibula project backwards at the lower end, while the ankle and foot are again inclined in the same direction as the femur. With the fore-limbs there is not this regular alternation. The humerus is directed backwards, the fore-arm forwards, and the hand still more forwards. This angulation seems to facilitate movement, inasmuch as it is seen in even the Amphibia and the lower Reptiles, in which, however, the differences between the fore- and hind-limbs are less marked, indicat-

ing therefore a less specialised condition of the limbs. It is an interesting fact that the angulation of the limbs is to some extent obliterated in very bulky creatures, and almost entirely so in the elephants (see p. 217), which seem to need strong and straight pillars for the due support of their huge bodies.

The alertness and general intellectual superiority of mammals to all animals lying below them in the series (with the exception of the birds, which are in their way almost on a level with the Mammalia) are seen by their active and continuous movements. The lengthy periods of absolute motionlessness, so familiar to everybody in such a creature as the Crocodile, are unknown among the more typical Mammalia except indeed during sleep. This mental condition is clearly shown by the proportionate development of the external parts of all the organs of the higher senses. The Mammalia as a rule have well-developed, often extremely large, flaps of skin surrounding the entrance to the organ of hearing, often called "ears," but better termed "pinnae." These are provided with special muscles, and can be often moved and in many directions. The nose is always, or nearly always, very conspicuous by its naked character; by the large surface, often moist, which surrounds the nostrils; and again by the muscles, which enable this tract of the integument to be moved at will. The eyes, perhaps, are less marked in their predominance over the eyes of lower Vertebrates than are the ears and nose; but they are provided as a rule with upper and lower eyelids, as well as by a nictitating membrane as in lower Vertebrates. The apparent predominance of the senses of smell and hearing over that of sight appears to be marked in the Mammalia, and may account for their diversity of voice as well as of odour, and for the general sameness of coloration which distinguishes this group from the brilliantly-coloured birds and reptiles. The head, too, which bears these organs of special sense, is more obviously marked out from the neck and body than is the case with the duller creatures occupying the lower branches of the Vertebrate stem.

The Hair.—The Mammalia are absolutely distinguished from all other Vertebrates (or, for the matter of that, Invertebrates) by the possession of hair. To define a mammal as a Vertebrate with hair would be an entirely exclusive definition; even in the smooth Whales a few hairs at least are present, which may be

reduced to as few as two bristles on the lips. The term "hair," however, is apt to be somewhat loosely applied; it has been made use of to describe, for example, the slender processes of the



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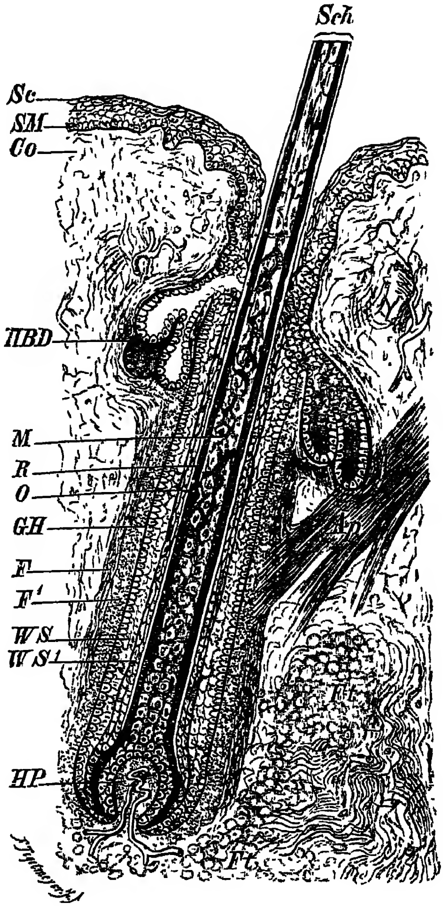

B

FIG. 1.—A, Section of human skin. *Co*, Dermis; *D*, sebaceous glands; *F*, fat in dermis; *G*, vessels in dermis; *GP*, vascular papillae; *H*, hair; *N*, nerves in dermis; *NP*, nervous papillae; *Sc*, horny layer of epidermis; *SD*, sweat gland; *SD*¹, duct of sweat gland; *SM*, Malpighian layer. B, Longitudinal section through a hair (diagrammatic). *Ap*, Band of muscular fibres inserted into the hair-follicle; *Co*, corium (dermis); *F*, external longitudinal; *F*¹, internal circular, fibrous layer of follicle; *Ft*, fatty tissue in the dermis; *GH*, hyaline membrane between the root-sheath and the follicle; *HBD*, sebaceous gland; *HP*, hair-papilla with vessels in its interior; *M*, medullary substance (pith) of the hair; *O*, cuticle of root-sheath; *R*, cortical layer; *Sc*, horny layer of epidermis; *Sch*, Hair shaft; *SM*, Malpighian layer of epidermis; *WS*, *WS*¹, outer and inner layers of root-sheath. (From Wiedersheim's *Comparative Anatomy*.)

chitinous skin of the Crustacea. It will be necessary, therefore, to enter into the microscopical structure and development of the mammalian hair. Hair is found in every mammal. The first appearance of a hair is a slight thickening of the stratum Malpighii of the epidermis, the cells taking part in this being

elongated and converging slightly above and below. Dr. Maurer has called attention to the remarkable likeness between the embryonic hair when at this stage and the simple sense-organs of lower Vertebrates. Later there is formed below this a denser aggregation of the corium, which ultimately becomes the papilla of the hair. This is the apparent homologue of the first formed part of a feather, which projects as a papilla before the epidermis has undergone any modification. Hence there is from the very first a difference between feathers and hairs—a difference which must be carefully borne in mind, especially when we consider the strong superficial resemblance between hairs and the simple barbless feathers. Still later the knob of epidermic cells becomes depressed into a tubular structure, which is lined with cells also derived from the stratum Malpighii, but is filled with a continuation of the more superficial cells of the epidermis. This is the hair-follicle, and from the epidermic cells arises the hair by direct metamorphosis of those cells; there is no excretion of the hair by the cells, but the cells become the hair. From the hair-follicle also grows out a pair of sebaceous glands, which serve to keep the fully-formed hair moist.

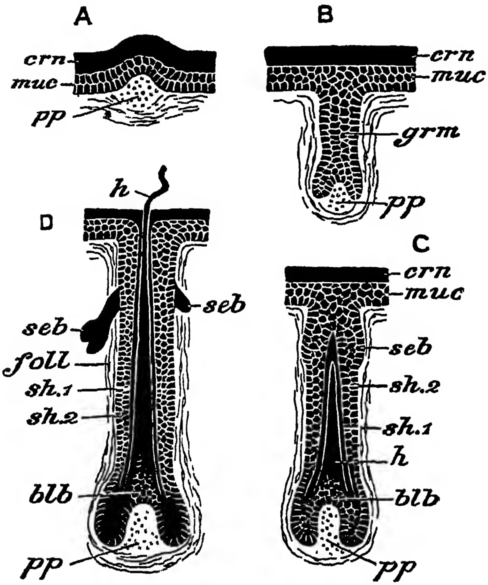

FIG. 2.—Four diagrams of stages in the development of a hair. A, Earliest stage in one of those mammals in which the dermal papilla appears first; B, C, D, three stages in the development of the hair in the human embryo. *blb*, Hair-bulb; *crn*, horny layer of the epidermis; *foll*, hair-follicle; *grm*, hair-germ; *h*, hair, in D, projecting on the surface; *muc*, Malpighian layer of epidermis; *pp*, dermal papilla; *seb*, developing sebaceous glands; *sh*.1, *sh*.2, inner and outer root-sheaths. (After Hertwig.)

Dr. Meijerle[1] has lately described in some detail the parti-

[1] "Über die Haare der Saugethiere," *Morph. Jahrb.* xxi. 1894, p 312.

cular arrangement of the individual hairs among mammals; they are not by any manner of means scattered without order, but show a definite and regular arrangement, which varies with the animal. For instance, in an American Monkey (*Midas*), the hairs arise in threes—three hairs of equal size springing from the epidermis close together; in the Paca (*Coelogenys*) there are in each group three stout hairs alternating with three slender hairs In some forms a number of hairs spring from a common point: in the Jerboa (*Dipus*) twelve or thirteen arise from a single hole, in *Ursus arctos* there is the same general plan, but there is one stout hair and four or five slender ones. There are numerous other complications and modifications, but the facts, although interesting, do not appear to throw any light upon the mutual affinities of the animals. Allied forms may have a very different arrangement, while in forms which have no near relationship the plan may be very similar, as is shown by the examples cited from Dr. Meijerle's paper. The groups of hairs, moreover, have themselves a definite placing, which the same anatomist has compared with the disposition of the bundles of hairs behind and between the scales of the Armadillo, and which has led him to the view that the ancestors of mammals were scaly creatures—a view also supported by Professor Max Weber,[1] and not in itself unreasonable when we consider the numerous points of affinity between the primitive Mammalia and certain extinct forms of reptiles.[2]

The hairs are greatly modified in form in different mammals and in different parts of their bodies. It is very commonly the case that a soft under-fur can be distinguished from the longer and coarser hairs, which to some extent hide the latter. Thus the "sealskin" of commerce is the under-fur of the *Otaria ursina* of the North. The coarser hairs may be further differentiated into bristles; these again into spines, such as those of the Hedgehog and of the Porcupine. Again, the flattening and agglutination of hairs seems to be responsible for the scales of the *Manis*

[1] "Bemerkungen uber den Ursprung der Haare," *Anat. Anz.* 1893, p. 413.

[2] See for this matter, p. 90. Dr. Bonavia has recently advanced (*Studies in Evolution*, London, 1895) the somewhat fantastic view that the pigment-patches of Carnivorous and other mammals are a reminiscence of an earlier scaly condition. There is no direct evidence that the primitive mammals were scaly, nor are the Monotremata or Marsupials furnished with any more traces of such a condition than are other mammals: and they are the most lowly organised of existing Mammalia

and for the horns of the *Rhinoceros.* It is a matter of common knowledge that upon the head of various animals, *e.g.* the Domestic Cat, long and sensitive hairs are developed, which are connected with the terminations of nerves, and perform a sensory, probably tactile function. These occur on the snout, above the eyes, and in the neighbourhood of the ears. It is an interesting fact that a tuft of quite similar hairs occurs on the hand of many mammals close to the wrist, which, at least in the case of *Bassaricyon,* are connected with a strong branch from the arm-nerve. These tufts also occur in Lemurs, in the Cat, various Rodents and Marsupials, and are probably quite general in mammals who "feel" with their fore-limbs;—in which, in fact, the fore-limbs are not exclusively running organs. That the last remaining hairs of the Cetacea are found upon the muzzle, is perhaps significant of the importance of these sensory bristles. The entire absence of hairs is quite common in this order, although traces of them are sometimes found in the embryo. The Sirenia, too, are comparatively hairless, as are also many Ungulates. Whether the presence of blubber in the former case and the existence of a very thick skin in the latter animals are facts which have had anything to do with the disappearance of hair or not, is a matter for further inquiry.

The intimate structure of the hair varies considerably. The variations concern the form of the hair, which may be round in transverse section, or so oval as to appear quite flat when the hair is examined in its entirety. The substance of the hair is made up of a central medulla or pith with a peripheral cortex; the latter is scaled, and the scales are often imbricated and with prominent edges. The amount of the two constituents also differs, and the cortex may be reduced to a series of bands surrounding only tracts of the enclosed pith. In the hair is contained the pigment to which the colour of mammals is chiefly due. Tracts of brightly-coloured skin may exist, as in the Apes of certain genera; but such structures are not general. The pigment of the hair seems to consist of those pigmentary substances known as melanins. It is remarkable to find such an uniform cause of coloration, when we consider the great variety of feather-pigments found in birds. The variations of colour of the hair of mammals are due to the unequal distribution of these brown pigments. There are very few mammals which can

be called brightly coloured. The Bats of the genus *Kerivoula* have been compared to large butterflies, and some of the Flying Squirrels have strongly-marked contrasts of reddish brown, white, and yellow. The same may be said of the spines of certain Porcupines. But we find in the hair no bright blues, greens, and reds such as are common among birds.

There are certain general facts about the coloration of mammals which require some notice here. Next to the usually sombre hues of these animals the general absence of secondary sexual coloration is noteworthy. In but a few cases among the Lemurs and Bats do we find any marked divergences in hues between males and females. Secondary sexual characters in mammals are, it is true, often exhibited by the great length of certain hair-tracts in the male, such as the mane of the Lion, the throat- and leg-tufts of the Barbary Sheep, and so forth; but apart from these, the secondary sexual characters of mammals are chiefly shown in size, *e.g.* the Gorilla, or in the presence of tusks, *e.g.* various Boars, or of horns, as in the Deer, etc. The coloration of mammals frequently exhibits conspicuous patterns of marking. These are in the form of longitudinal stripes, of cross-stripes, or of spots; the latter may be "solid" spots, or broken up, as in the Leopard and Jaguar, into groups of smaller spots arranged in a rosette-fashion. We never find in mammals the complicated "eyes" and other markings which occur in so many birds and in other lower Vertebrates. It is important to note that in the Mammalia whose sense of sight is quite keen there should be a practical absence of secondary sexual colours. As to the relationship of the various forms of marking that do occur, it seems clear that there has been a progression from a striped or spotted condition to uniform coloration. For we find that many Deer have spotted young; that the young Tapir of the New World is spotted, while its parents are uniform blackish brown; the strongly-marked spotting of the young Puma contrasts with the uniform brown of the adult; and the Lion cub, as every one knows, is also spotted, the adult lioness showing considerable traces of the spots.

The seasonal change in the colours of certain mammals is a subject upon which much has been written. The extreme of this is seen in those creatures, such as the Polar Hare and the Arctic Fox, which become entirely blanched in the winter, recovering

their darker coat in the spring. This is, however, only an extreme case of a change which is general. Most animals get a thicker fur in winter and exchange it for a lighter one in summer. And the hues of the coat change in correspondence.

Glands of the Skin.—The great variety of integumental glands possessed by the Mammalia distinguishes them from any group of lower Vertebrates. This variability, however, only concerns the anatomical structure of the glands in question. Histologically they are all of them apparently to be referred to one of two types, the sudoriparous or sweat gland and the sebaceous gland. Simple sweat and sebaceous glands are abundant in mammals, with but a few exceptions. The structures that we are now concerned with are agglomerations of these glands. The mammary glands will be treated of in connexion with the marsupium; they are either masses of sweat glands, or of sebaceous glands whose secretion has been converted into milk.

Many Carnivora possess glands opening to the exterior, near the anus, by a large orifice. These secrete various odoriferous substances, of which the well-known "civet" is an example. Other odoriferous glands are the musk glands of the Musk-deer and of the Beaver; the suborbital gland of many Antelopes; the dorsal gland of the Peccary, which has given the name of *Dicotyles* to the genus on account of its resemblance in form to a navel. This gland may be seen to secrete a clear watery fluid The Elephant has a gland situated on the temple, which is said to secrete during certain periods only, and to be a warning to leave the animal alone. Very remarkable are the foot glands of certain species of *Rhinoceros;* they are not universally present in those animals, and are therefore useful as specific distinctions. On the back of the root of the tail in many Dogs are similar glands. The Gentle Lemur (*Hapalemur*) has a peculiar gland upon the arm, about the size of an almond, which in the male underlies a patch of spiny outgrowths. In *Lemur varius* is a hard patch of black skin which may be the remnants of such a gland. It is thought that the callosities on the legs of Horses and Asses are remnants of glands.

One of the most complex of these structures which has been examined microscopically exists in the Marsupial *Myrmecobius.*[1] On the skin of the anterior part of the chest, just in front of the

[1] *Proc. Zool. Soc.* 1887, p. 527.

sternum, is a naked patch of skin which is seen to be perforated by numerous pores. Besides the ordinary sebaceous and sweat glands there are a series of masses of glands, opening by larger orifices, which present the appearance of groups of sebaceous glands, and are of a racemose character; but the existence of muscular fibres in their coats seems to show that they should be referred rather to the sudoriparous series. Beneath the integument is a large compound tubular gland quite half an inch in diameter.

In *Didelphys dimidiata* there is a precisely similar glandular area and large underlying gland, the correspondence being remarkable in two Marsupials so distant in geographical position and affinities. Even among the Diprotodont genera there is something of the kind; for in *Dorcopsis luctuosa* and *D. muelleri* is a collection of four unusually large sebaceous follicles upon the throat, and in the Tree Kangaroo (*Dendrolagus bennettii*) there is the same collection of enlarged hair-follicles, though they are apparently somewhat reduced as compared with those of *Dorcopsis*. These are of course a few examples out of many.

It seems to be possible that the functions of these various glands is at least twofold. In the first place, they may serve, where predominant in one sex, to attract the sexes together. In the second place, the glands may be useful to enable a strayed animal of a gregarious species to regain the herd. It is perfectly conceivable too that in other cases the glands may be a protection, as they most undoubtedly are in the Skunk, from attacks In connexion with the first, and more especially the second, of the possible uses of these glands, it is interesting to note that in purely terrestrial creatures, such as the Rhinoceros, the glands are situated on the feet, and would therefore taint the grass and herbage as the animal passed, and thus leave a track for the benefit of its mate. The same may be said of the rudimentary glands of Horses if they are really glands. The secretion of the "crumen" of Antelopes is sometimes deposited deliberately by *Oreotragus* upon surrounding objects, a proceeding which would attain the same end. One may even perhaps detect "mimicry" in the similar odours of certain animals. Prey may be lured to their destruction, or enemies frightened away. The defenceless Musk-deer may escape its foes by the suggestion of the musky odour of a crocodile. It is at any rate perfectly conceivable that the variety of odours among mammals may play a very

important part in their life, and it is perhaps worthy of note that birds with highly-variegated plumage are provided only with the uropygial gland, while mammals with usually dull and similar coloration have a great variety of skin glands. Scent is no doubt a sense of higher importance in mammals than in birds. The subject is one which will bear further study.

Nails and Claws.—Except for the Cetacea (where rudiments have been found in the foetus), the extremities of the fingers and of the toes of mammals are covered by, or encased in, horny epidermic plates, known as nails, claws, and hoofs.

The variety in the shape and development of these corneous sheaths to the digits is highly characteristic of mammals as opposed to lower Vertebrates. If we take extreme cases, such as the nail of the thumb in Man, the hoof of a Horse, and the claw of a Cat, it is easy to distinguish the three kinds of phalangeal horny coverings. But the differences become extinguished as we pass from these to related types. The nail of the little finger in Man approaches the claw-like form; and the hoofs of the Lama are almost claws in the sharpness of their extremities. On the whole it may be said that claws and hoofs embrace the bone which they cover, while nails lie only upon its dorsal surface. The form of the distal phalanx which bears the nail shows, however, two kinds of modification which do not support such a classification. When those phalanges are clad with hoofs or covered by a nail they end in a rounded and flattened termination. On the other hand, when they bear a claw they are themselves sharpened at the extremity and often grooved above.

The Marsupium.—It may appear to be unnecessary at this juncture to speak of the marsupial pouch, which is so usually believed to be a characteristic of the group Marsupialia. Rudiments of this structure have, however, been recently discovered in the higher mammals, and, as Dr. Klaatsch[1] has remarked, all researches into the "history of the mammals culminate in the question whether the placental mammals pass through a marsupial stage or not." We cannot, therefore, look upon the marsupial pouch as a matter affecting only the Marsupials, though it is true that this organ is at present functional only in them and in the Monotremata.

[1] "Über Marsupialrudimente bei Placentaliern," *Morph. Jahrb.* xx. 1893, p. 276.

In the Marsupials the pouch shelters the young, which are born in an exceedingly imperfect state, minute, nude, and blind, with a "larval" mouth fitted only to grasp in a permanent fashion the teat, upon which they are carefully fixed by the parent. But even later the pouch is made use of as a temporary harbour of refuge: from the pouch of female Kangaroos at the Zoological Gardens may frequently be observed to protrude the tail

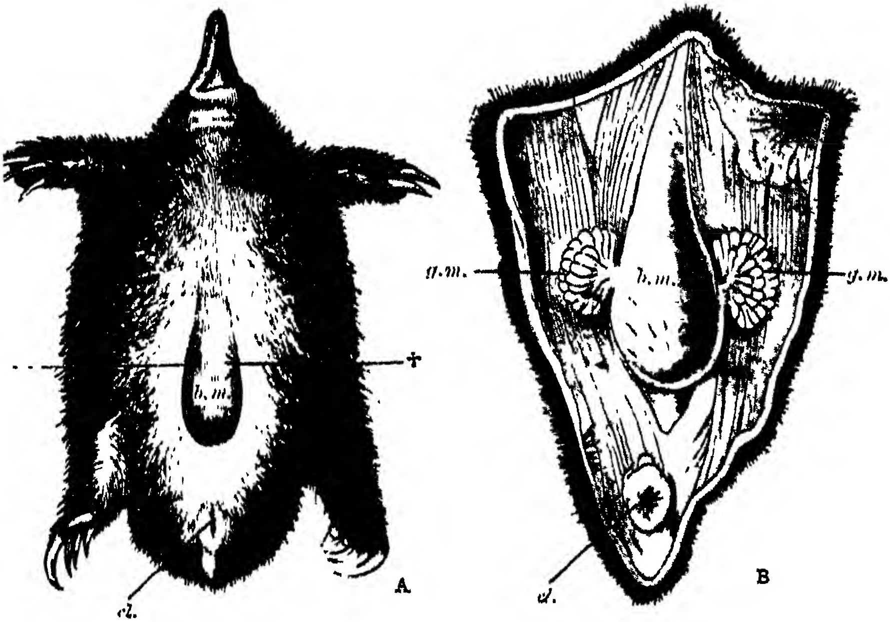

FIG. 3. *Echidna hystrix.* **A.** Lower surface of brooding female ; **B**, dissection showing a dorsal view of the pouch and mammary glands ; †† the two tufts of hair in the lateral folds of the mammary pouch from which the secretion flows. *b.m.* Pouch ; *cl*, cloaca ; *g.m*, groups of mammary glands. (From Wiedersheim's *Comparative Anatomy*, after W. Haacke.)

and hind-legs of a young Kangaroo as big as a Cat, and perfectly well able to take care of itself.

In the Monotremata (in *Echidna*) there is a deep fold of the skin which lodges the unhatched egg, and into which the mammary glands open, one on either side. This structure is only periodically developed, and arises from two rudiments, one corresponding to each mammary area ; but in the female with eggs or young there is but a single deep depression, which occupies the same region of the body as the marsupial pouch of the Mar-

supials.[1] It is usually held that this structure is not of precisely the same morphological value as the pouch of the Marsupial; and the difference is expressed by terming the one (that of *Echidna*) the mammary pouch, and the other the marsupium. At first sight it may appear to be an unnecessary refinement to separate two structures which have so many and such obvious likenesses. It is not quite certain, however, that the difference is not even more profound than later opinions seem to indicate. The Monotremata not only have no teats, as has already been pointed out, but the mammary glands themselves are of a perfectly different nature to those of the higher mammals, including the Marsupials There is therefore no *a priori* objection to the view that the accessory parts developed in connexion with the mammary glands should also be different. The teat of the higher Mammalia grows up round the area upon which the ducts of the mammary glands open; it is a fold of skin which eventually assumes the cylindrical form of the adult teat, and which includes the ducts of the milk glands. It has been suggested that the two folds of skin which form the mammary pouch of *Echidna* are to be looked upon as the equivalent of the commencing teat of the higher mammal.[2] In this case it is clear that the marsupial folds of the Marsupial cannot correspond accurately with the apparently similar folds of *Echidna*, because there are teats as well. It is the teats which correspond to the marsupial folds of *Echidna*. This view is in apparent contradiction to an interesting discovery in a specimen of a Phalanger by Dr. Klaatsch.[3] This Marsupial, like most others, has a well-developed marsupial pouch, in which the young are lodged at birth; but round two of the teats is another distinct fold on either side, the outer wall of which forms the general wall of the pouch. Dr. Klaatsch thinks that these smaller and included pouches are the equivalents of the mammary pouches of *Echidna*. They contain teats, but this comparison does not do away with the validity of Gegenbaur's suggestion already referred to, because the teats are (see above)

[1] See Haacke, "On the Marsupial Ovum, the Mammary Pouch, etc., of the Echidna," *Proc. Roy. Soc.* 1885, p. 72; and "Über die Entstehung der Säugetiere," *Biol. Centralbl.* viii. 1889, p. 8.

[2] See Gegenbaur's *Elements of Comp. Anat.* Transl. by Bell, 1878, p. 421.

[3] "Über die Beziehungen zwischen Mammartasche u. Marsupium," *Morph. Jahrb.* xvii. 1891, p. 483.

secondary. If this fact be fairly to be interpreted in the sense which Dr. Klaatsch attaches to it, we have an interesting case of the growth of a new organ out of and partly replacing an old organ. In the Monotremes there is a pouch which facilitates or performs both nutritive and protective functions; in the Phalanger these two functions are carried on in separate pouches; finally, in other Marsupials, there is a return to the undifferentiated state of affairs found in the Monotremata, but with the help of a new organ not found in them.

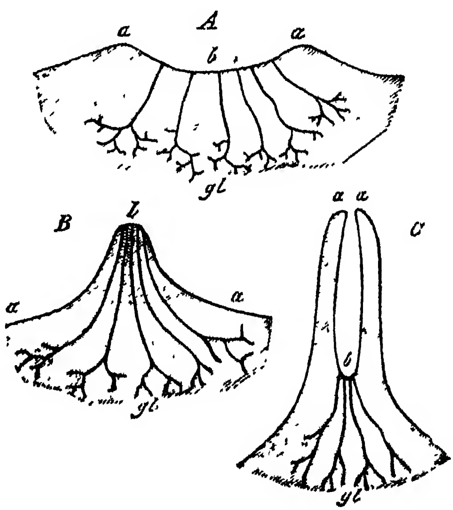

FIG. 4.—Diagram of the development of the nipple (in vertical section). **A**, Indifferent stage, glandular area flat; **B**, elevation of the glandular area with the nipple; **C**, elevation of the periphery of the glandular area into the false teat. *a*, Periphery of the glandular area; *b*, glandular area; *gl*, glands. (From Gegenbaur.)

Though so characteristic of Marsupials, the marsupial pouch is not always developed in them. It is present in all the Kangaroos, Wallabies, and Wombats, in fact in the Diprotodonts. It is also present in a number of the carnivorous Polyprotodont Marsupials; but in *Phascologale* it is only present in rudiment, and in *Myrmecobius* it is entirely obsolete. In the American Opossums the state of the pouch is variable. "Generally absent, sometimes merely composed of two lateral folds of skin separate at each end, rarely complete," is Mr. Thomas' summary in his definition of the family Didelphyidae.[1] Another curious feature of the pouch in the Marsupials is the variability in the position of the mouth of the pouch: in all the Diprotodonts it looks forward, but in many Polyprotodonts it looks backward. This, however, has some connexion with the habitual attitude of the possessor: in the Kangaroo, leaping along on its hind-legs, it is requisite that the pouch should open forwards; but in the dog-like Thylacine, going on all fours, the fact that the pouch

[1] *Catalogue of Marsupials in British Museum*, 1886.

opens backwards is less disadvantageous to the contained young.

The male Thylacine has a pouch which is quite or very nearly as well formed as in the female. There are also rudiments of a pouch in the male foetuses of many Marsupials, especially of those belonging to the Polyprotodont section of the order, though these rudiments are by no means confined to that subdivision. Up to so late a period as the age of four months (length 19·8 cm.) the male *Dasyurus ursinus* has a pouch.

We have now to consider the interesting series of facts relative to the permanence—in a rudimentary condition it is true—of the mammary pouch in the higher Mammalia, facts which seem to be an additional proof that they have been derived from an ancestor in which the pouch was an organ of functional importance. The first definite proof of the occurrence of a pouch in any mammal not a Marsupial or a Monotreme was made by Malkmus, who found this structure in a Sheep. It seems, however, that the structures found in the higher mammals are not always comparable to the marsupium of the Marsupials, but sometimes to the mammary pouch of the Monotreme. That the Marsupials are a side line, and not involved in the ancestry of the Eutheria, is an opinion which is at present widely held. At the same time it is reasonable to suppose that the original stock lying between the Prototheria and the Metatheria, whence the latter and the Eutheria have arisen, preserved both the mammary pouch of the lower mammal and the marsupium of the further-developed stage, as does *Phalangista* occasionally at the present day. Hence to find remnants of both structures in existing mammals would not be incredible. This is what Dr. Klaatsch believes to be the case. In certain Ungulates, including two species of Antelope, Dr. Klaatsch found very considerable rudiments of folds provided with unstriated muscular fibre; there were in the adult *Cervicapra isabellina* a pair of pouches, one on each side, and a rudiment of a second on either side; possibly this multiplication of the pouches has relation to the number of young. That there is more than one pouch makes a comparison with the mammary pouch rather than with the marsupium probable. The Ungulate teat, it must be remembered (see p. 16), is a secondary teat; hence there is no difficulty in the comparison from this point of view. A pouch containing a primary

teat would of course be absolutely incomparable with a mammary pouch, because in that case the wall of the teat itself would be the pouch.

Mammals belonging to quite different Orders show traces more or less marked of a marsupium. In young Dogs the teats are borne upon an area where the skin is thinner, the covering of hair less dense than elsewhere—all points of resemblance to the inside of the pouch of a Marsupial; in addition to this there are traces of the sphincter marsupii muscle. In other Carnivora there are similar vestiges. In *Lemur catta* a more complete rudiment of a marsupial pouch is to be met with. In this Lemur the teats are both inguinal and pectoral; the skin in these regions is thin and but slightly hairy, and extends forwards as two bands of the same thinness and smoothness on each side of the densely hairy skin covering the sternum. This area is sharply separated from the rest of the integument by a fold which runs parallel to the longitudinal axis of the body, and can be comparable with nothing save the rudiment of the marsupial fold.

One is tempted to wonder how far the habit which certain Lemurs have of carrying their young across the abdomen with the tail wrapped round the body of the mother is a reminiscence of a marsupial pouch.

Skeleton.

The skeleton of the Mammalia consists almost solely of the endoskeleton. It is only among the Edentata that an exoskeleton of bony plates in the skin is met with. As in other Vertebrates, the skeleton is divisible into an axial portion, the skull and vertebral column, and an appendicular skeleton, that of the limbs. The bones of mammals are well ossified, and in the adult there are but few and small tracts of cartilage left

Vertebral Column.—The vertebral column of the mammals, like that of the higher Vertebrata, consists of a number of separate and fully-ossified vertebrae.

The constitution of a vertebra upon which all the usual processes are marked is as follows:—There is first of all the body or centrum of the vertebra, a massive piece of bone shaped like a disc or a cylinder. The centra of contiguous vertebrae

are separated by a certain amount of fibrous tissue forming the intervertebral disc, and the apposed surfaces of the centra are as a rule nearly flat. In this last feature, and in the important fact that the centra are ossified from three distinct centres, the anterior and posterior pieces (" epiphyses ") remaining distinct for a time, even for a long time (as in the Whales), the centra in the mammals differ from those of reptiles and birds. The epiphyses are not found throughout the vertebral column of the lowly-organised Monotremata, and they do not appear to exist in the Sirenia.

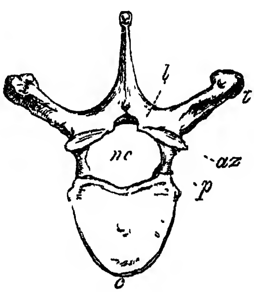

FIG. 5.—Anterior surface of Human thoracic vertebra (fourth) × ⅔. *az*, Anterior zygapophysis; *c*, body or centrum; *l*, lamina, and *p*, pedicle, of the neural arch, *nc*, neural canal; *t*, transverse process. (From Flower's *Osteology of the Mammalia*.)

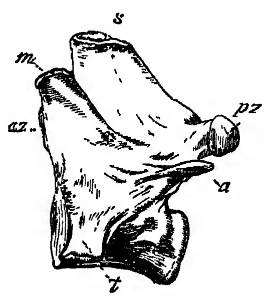

FIG. 6—Side view of first lumbar vertebra of Dog (*Canis familiaris*). × ⅘. *a*, Anapophysis; *az*, anterior zygapophysis, *m*, metapophysis; *pz*, posterior zygapophysis; *s*, spinous process; *t*, transverse process (From Flower's *Osteology*.)

From each side of the centrum on the dorsal side arises a process of bone which meets its fellow in the middle line above, and is from there often prolonged into a spine. A canal is thus formed which lodges the spinal cord. This arch of bone is known as the neural arch, and the dorsal process of the same as the spinous process. The sides of the neural arch bear oval facets, by which successive vertebrae articulate with one another: those situated anteriorly are the anterior zygapophyses, while those on the posterior aspect of the arch are the posterior zygapophyses; these articular facets do not exist in the tail-region of many mammals, *e.g.* Whales.

In addition to the dorsal median spinous process of the

vertebra there may be a ventral median process, arising of course from the centrum, termed the hypapophysis.

From the sides of the neural arch, or from the centrum itself, there is commonly a longer or shorter process on each side, known as the transverse process. This is sometimes formed of two distinct processes, one above the other; in such cases the upper part is called a diapophysis, the lower a parapophysis.

The neural arch may also bear other lateral processes, of which one directed forwards is the metapophysis, the other directed backwards the anapophysis.

The series of bones which constitute the vertebral column can be divided into regions. It is possible to recognise cervical, dorsal, lumbar, sacral, and caudal vertebrae. In the case of animals with only rudimentary hind-limbs, such as the Whales, there is no recognisable sacral region. The neck or cervical vertebrae are nearly always seven in number. The well-known exceptions are the Manatee, where there are six, and certain Sloths, where there are six, eight, or nine. These rare exceptions only accentuate the very remarkable constancy in number, which is very distinctive of the mammals as compared with lower Vertebrata. There are of course abnormalities, the last cervical, and sometimes the last two, assuming the characters of the ensuing dorsals, by developing a more or less complete rib. There are also recorded examples of *Bradypus*, in which the number of cervicals is increased to ten. The characteristics, then, of the cervical vertebrae are, in the first place, that they do not normally bear free ribs, and that there is a break as a rule between the last cervical and the first dorsal on this account. In birds, for example, the cervicals, differing in number in different families and genera, gradually approach the dorsals by the gradually lengthening ribs. The transverse processes of the vertebrae are commonly perforated by a canal for the vertebral artery, and are bifid at their extremities. In some Ungulates these vertebrae, moreover, approximate to the vertebrae of lower Vertebrata in the fact that there are ball and socket joints between the centra, instead of only the fibrous discs of the remaining vertebrae.

The first two vertebrae of the series are always very different from those which follow The first is termed the

atlas, and articulates with the skull. The most remarkable fact about this bone (shared, however, by lower Vertebrates) is that its centrum is detached from it and attached to the next vertebra, in connexion with which it will be referred

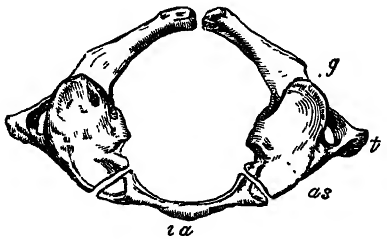

FIG 7.—Human atlas (young), showing development ×¾. *as*, Articular surface for occiput; *g*, groove for first spinal nerve and vertebral artery; *i a*, inferior arch, *t*, transverse process. (From Flower's *Osteology*.)

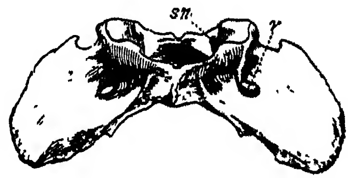

FIG. 8.—Inferior surface of atlas of Dog ×½. *sn*, Foramen for first spinal nerve; *v*, vertebrarterial canal. (From Flower's *Osteology*.)

to immediately. The whole bone thus gets a ring-like form, and the salient processes of other vertebrae are but little developed, with the exception of the 'transverse processes, which are wide and wing-like. In many Marsupials, such as the Wombat and Kangaroo, the arch of the atlas is open below, there being no centre of ossification. In others, such as *Thylacinus*, there is a distinct nodule of bone in this situation not concrescent with the rest of the arch.

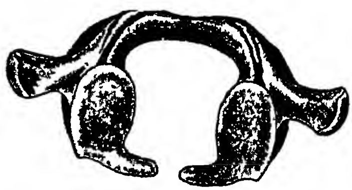

FIG. 9.—Atlas of Kangaroo. (From Parker and Haswell's *Zoology*.)

The second vertebra, which is known as the axis or epistropheus, is a compound structure, the anterior "odontoid process," which fits into the ring of the atlas, being in reality the detached centrum of that vertebra.[1] It is a curious fact about that process that it has independently become spoon-shaped in two divisions of Ungulates; that it has become so seems to be shown by the fact that in the earlier types of both it has the simple peg-like form, which is the prevailing form. The cervical

[1] Its independence from the epistropheus is emphasised in Monotremes and some Marsupials by its late fusion with that vertebra.

vertebrae are occasionally wholly (Right Whales) or partially (many Whales, Jerboa, certain Edentates) welded into a com-

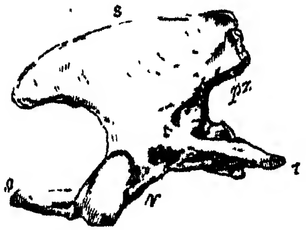

FIG. 10.—Side view of axis of Dog. × ⅔. *o*, Odontoid process; *pz*, posterior zygapophysis; *s*, spinous process; *t*, transverse process; *v*, vertebrarterial canal. (From Flower's *Osteology*.)

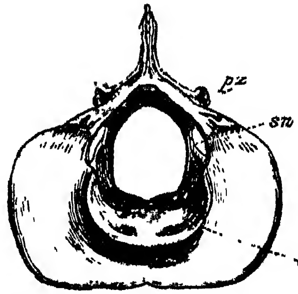

FIG. 11. Anterior surface of axis of Red Deer. × ⅜. *o*, Odontoid process; *pz*, posterior zygapophysis; *sn*, foramen for second spinal nerve. (From Flower's *Osteology*.)

bined mass. Indications of this have even been recorded in the human subject.

The dorsal vertebrae vary greatly in number: nine (*Hyperoodon*) seems to be the lowest number existing normally; while there may be as many as nineteen, as in *Centetes*, or twenty-two, as in *Hyrax*. These vertebrae are to be defined by the fact that they carry ribs, and the first one or two lumbars are often "converted into" dorsals by the appearance of a small supernumerary rib. The spinous processes of these vertebrae are commonly long, and sometimes very long. It is only among the Glyptodons that any of these vertebrae are fused together into a mass.

The lumbar vertebrae, which follow the dorsal, vary greatly in number. There are as few as two in the whale *Neobalaena*, as many as seventeen in *Tursiops*; this group, the Cetacea, contains the extremes. Nine lumbars are found in the Lemurs *Indris* and *Loris*. As a rule the number of lumbars is to some extent dependent upon that of the dorsals. It often happens that the number of thoraco-lumbar vertebrae is constant for a given group. Thus the Artiodactyles have nineteen of these vertebrae, and the Perissodactyles as a rule twenty-three. A greater number of dorsals implies a smaller number of lumbars, and of course *vice versa*. The existence of a sacral region formed of a

number of vertebrae fused together and supported by the pelvic girdle is characteristic of the mammals, but is not found in the Cetacea and the Sirenia, where functional hind-limbs are wanting. Strictly speaking, the sacrum is limited to the two or three vertebrae whose expanded transverse processes meet the ilia. But to these are or may be added a variable number of vertebrae withdrawn from both the lumbar and the caudal series, which

FIG. 12.—*Lepus cuniculus.* Innominate bones and sacrum, ventral aspect. *acet*, Acetabulum; *il*, ilium; *isch*, ischium; *obt*, obturator foramen, *pub*, pubis; *sacr*, sacrum; *sy*, symphysis. (From Parker and Haswell's *Zoology*.)

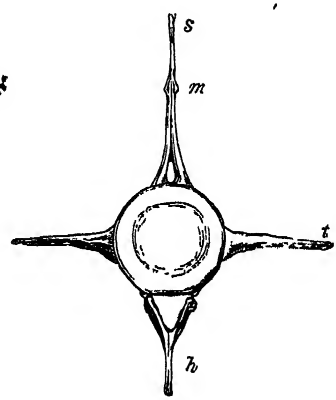

FIG. 13.—Anterior surface of fourth caudal vertebra of Porpoise (*Phocoena communis*). × ½. *h*, Chevron bone; *m*, metapophysis; *s*, spinous process; *t*, transverse process. (From Flower's *Osteology*.)

unite with each other to form the massive piece of bone which constitutes the sacrum of the adult.

The caudal vertebrae complete the series. They begin in as fully developed a condition as the lumbars, with well-marked transverse processes, etc.; but they end as no more than centra, from which sometimes tiny outgrowths represent in a rudimentary way the neural arches, etc. Very often the caudal vertebrae are furnished with ventral, generally V-shaped, appendages, the chevron bones or intercentra.[1] These are

[1] Intercentra are but rarely met with anterior to the caudal series. Mr. Parsons has, however, recorded their occurrence in the lumbar vertebrae of *Atherura*

particularly conspicuous in the Whales and in the Edentates. In the former group the occurrence of the first intercentrum serves to mark the separation of the caudal from the lumbar series. The number of caudals varies from three in Man—and those quite rudimentary—to nearly fifty in *Manis macrura* and *Microgale longicaudata*.

The Skull.—The skull in the Mammalia differs from that of the lower Vertebrata in a number of important features, which will be enumerated in the following brief sketch of its structure.

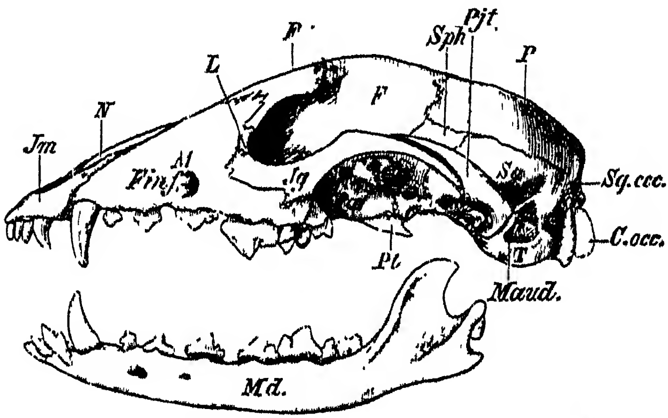

FIG. 11.—Lateral view of skull of a Dog. *C.occ*, Occipital condyles; *F*, frontal; *F.inf*, infra-orbital foramen; *Jg*, jugal; *Jm*, premaxilla; *L*, lachrymal; *M*, maxilla; *Maud*, external auditory meatus; *Md*, mandible; *N*, nasal; *P*, parietal; *Pal*, palatine; *Pjt*, process of squamosal; *Pt*, pterygoid; *Sph*, alisphenoid; *Sq*, squamosal; *Sq.occ*, supraoccipital; *T*, tympanic. (From Wiedersheim's *Comparative Anatomy*.)

In the first place, the skull is a more consolidated whole than in reptiles; the number of elements entering into its formation is less, and they are on the whole more firmly welded together than in Vertebrates standing below the Mammalia in the series. Thus in the cranial region the post- and pre-frontals, the post-orbitals and the supra-orbitals have disappeared, though now and again we are reminded of their occurrence in the ancestors of the Mammalia by a separate ossification corresponding to some of the bones. Nowhere is this consolidation seen with greater clearness than in the lower jaw. That bone, or rather each half of it, is in mammals formed of one bone, the dentary (to which occasionally, as it appears, a separate mento-Meckelian

ossification may be added). The angular, splenial, and all the other elements of the reptilian jaw have vanished, though the numerous points from which the mammalian dentary ossifies is a reminiscence of a former state of affairs; and here again an occasional continuance of the separation is preserved, as the case observed by Professor Albrecht of a separate supra-angular bone in a Rorqual attests. Among other reptilian bones that are not to be found in the mammalian skull are the basipterygoids, quadrato-jugal, and supratemporal. A few of these bones, however, though no longer traceable in the adult skull save in cases of what we term abnormalities, do find their representatives in the foetal skull. Professor Parker, for example, has described a supra-orbital in the embryo Hedgehog; a supratemporal also appears to be occasionally independent.

In the mode of the articulation of the lower jaw to the skull the Mammalia apparently, perhaps really, differ from other Vertebrates. In the Amphibia and Reptilia, with which groups alone any comparisons are profitable, the lower jaw articulates by means of a quadrate bone, which may be movably or firmly attached to the skull. In the mammals the articulation of the lower jaw is with the squamosal. The nature of this articulation is one of the most debated points in comparative anatomy. Seeing that Professor Kingsley[1] in the most recent contribution to the subject quotes no less than fifty-two different views, many of which are more or less convergent, it will be obvious that in a work like the present the matter cannot be treated exhaustively. As, however, Professor Kingsley justly says that "no single bone occupies a more important position in the discussion of the origin of the Mammalia than does the quadrate," and with equal justice adds that "upon the answer given as to its fate in this group depends, in large measure, the broader problem of the phylogeny of the Mammalia," it becomes, or indeed has long been a matter which cannot be ignored in any work dealing with the mammals. A simple view, due to the late Dr. Baur and to Professor Dollo, commends itself at first sight as meeting the case. The last-named author holds, or held, that in all the higher Vertebrates it is at least on *a priori* grounds likely that two such characteristically vertebrate features as the lower jaw and the chain of bones bringing the outer world

[1] *Tufts College Studies*, No. 6, 1900.

into communication with the internal organ of hearing would be homologous throughout the series. He believed, therefore, that the entire chain of ossicula auditus in the mammal is equal to the columella of the reptile, since their relations are the same to the tympanum on the one hand and to

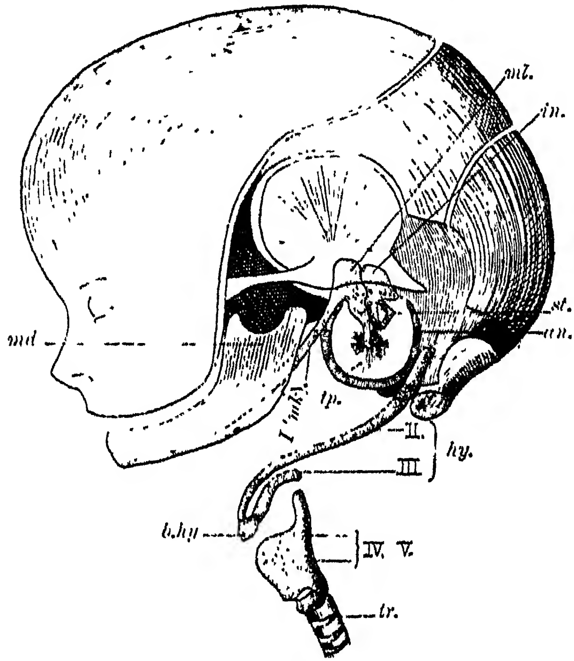

FIG. 15.—Head of a Human embryo of the fourth month. Dissected to show the auditory ossicles, tympanic ring, and Meckel's cartilage, with the hyoid and thyroid apparatus. All these parts are delineated on a larger scale than the rest of the skull. *an*, Tympanic ring; *b.hy*, basihyal element; *hy*, so-called hyoid bone; *in*, incus; *md*, bony mandible; *ml*, malleus; *st*, stapes; *tp*, tympanum; *tr*, trachea; I. (*mk*), first skeletal (mandibular) arch (Meckel's cartilage); II. second skeletal (hyoid) arch; III. third (first branchial) arch; IV. V. fourth and fifth arches (thyroid cartilage). (From Wiedersheim's *Structure of Man*.)

the foramen ovale on the other; and that the lower jaw articulates in the same way in both. It follows, therefore, that the glenoid part of the squamosal must be the quadrate which has become ankylosed with it after the fashion of concentration in the mammalian skull that has already been referred to. The fact that occasionally the glenoid part of the squamosal is a separate bone[1] appeared to confirm this way of looking at the

[1] Cf. the Armadillo *Peltephilus*, p. 186.

matter. But the hall-mark of truth is not always simplicity; indeed the converse appears to be frequently the case And on the whole this view does not commend itself to zoologists at present. For it must be borne in mind that the lower jaw of the mammal is not the precise equivalent of that of the reptiles. Apart from the membrane bones, which may be collectively the equivalents of the dentary of the mammal, there is the cartilaginous articular bone to be considered, which forms the connexion between the rest of the jaw and the quadrate in reptiles. Even in the Anomodontia, whose relations to the Mammalia are considered elsewhere, there is this bone. But in these reptiles the articular bone articulates not only with the quadrate, but also to a large extent with the squamosal, the quadrate shrinking in size and developing processes which give to it very much the look of either the incus or the malleus of the mammalian ear. In fact it seems on the whole to fit in with the views of the majority, as well as with a fair interpretation of the facts of embryology, to consider that the chain of ear bones in the mammal is not the equivalent of the columella of the reptile, but that the stapes of the mammal is the columella, and that the articulare is represented by the malleus and the quadrate by the incus. It is very interesting to note this entire change of function in the bones in question. Bones which in the reptile serve as a means of attachment of the lower jaw to the skull are used in the mammal to convey the waves of sound from the tympanum of the ear to the internal organ of hearing.

Another important and diagnostic feature in the mammalian skull is that the first vertebra of the vertebral column always articulates with two separate occipital condyles, which are borne by the exoccipital bones and formed mainly though not entirely by them. Certain Anomodontia form the nearest approach to the mammals in this particular. The two condyles of Amphibia are purely exoccipital in origin.

In the Mammalia, unlike what is found in lower Vertebrates (but here again the Anomodontia form at least a partial exception), the jugal arch does not connect the face with the quadrate, for, as already said, that bone does not exist, in the Sauropsidan form, in mammals. This arch passes from the squamosal to the maxillary, and has but one separate bone in addition to those two, viz. the jugal or malar.

In connexion with the elaboration of the chain of auditory ossicles it is very usual for mammals to possess a thin inflated bone, sometimes partly or entirely formed out of the tympanic bone, and known as the tympanic bulla. Whether this structure is thin and inflated or thick and depressed in form it is characteristic of the mammals, and does not occur below them in the series. But it is not present in all mammals. It is absent, for example, in the Monotremes When it is present it is sometimes formed from other bones, as, for instance, from the alisphenoids. The tympanic ring has been held to be the equivalent of the quadrate. It is more probably the quadrato-jugal[1]

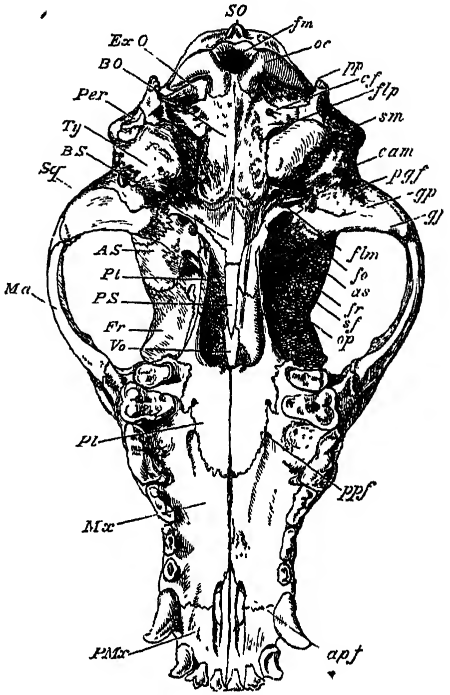

FIG. 16.—Under surface of the cranium of a Dog. × ⅓. *apf*, Anterior palatine foramen; *as*, posterior opening of alisphenoid canal; *AS*, alisphenoid; *BO*, basioccipital; *BS*, basisphenoid; *cf*, condylar foramen, *eam*, external auditory meatus; *Ex.O*, exoccipital; *flm*, foramen lacerum medium; *flp*, foramen lacerum posterius; *fm*, foramen magnum; *fo*, foramen ovale, *fr*, foramen rotundum; *Fr*, frontal; *gf*, glenoid fossa; *gp*, postglenoid process; *Ma*, malar; *Mx*, maxilla; *oc*, occipital condyle; *op*, optic foramen; *Per*, mastoid portion of periotic; *pgf*, postglenoid fossa; *Pl*, palatine; *PMx*, premaxilla, *pp*, paroccipital process; *ppf*, posterior palatine foramen; *PS*, presphenoid; *Pt*, pterygoid; *sf*, sphenoidal fissure or foramen lacerum anterius; *sm*, stylomastoid foramen; *SO*, supraoccipital; *Sq*, zygomatic process of squamosal; *Ty*, tympanic bulla; *Vo*, vomer. (From Flower's *Osteology*.)

Ribs. — All mammals are furnished with ribs, of which the number of pairs differs considerably from group to group, or it may be even from species to species. The ribs are attached as a rule by two heads, of which one, the capitulum, arises as a rule between two centra of successive vertebrae. The other, the tuberculum, springs from the transverse process. Only in the Monotremes

[1] Gegenbaur, *Vergl. Anat Wirbelth.* Leipzig, 1898, p. 404.

are there ribs with but one, the capitular, head. In the posterior part of the series the two heads often gradually coalesce, so that there comes to be but one, the capitular, head. The Whales also, at least the Whalebone Whales, are exceptional in possessing but one head to the ribs, which is the capitular. The first rib joins the sternum below, and a variable number after this have the same attachment. There are always a number of ribs, sometimes called floating ribs, which have no sternal attachment. In the Whalebone Whales

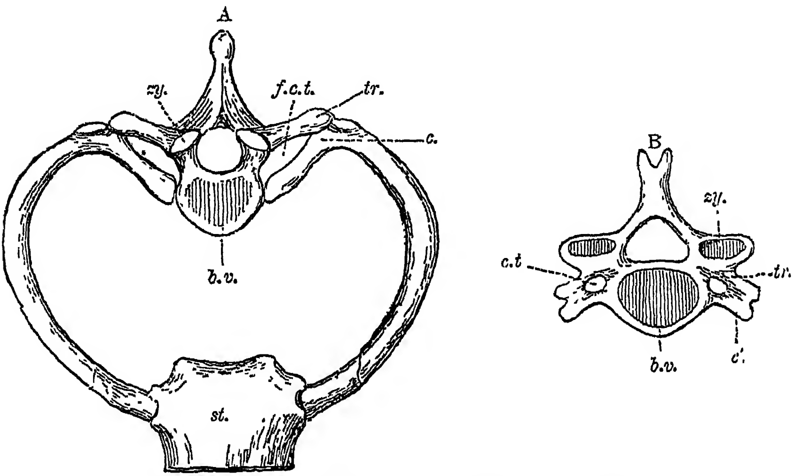

FIG. 17.—A, First thoracic skeletal segment for comparison with B, fifth cervical vertebra (Man). *b.v*, Body of vertebra; *c*, first thoracic rib; *c'*, cervical rib (which has become united with the transverse process, *tr*), the two enclosing the costo-transverse foramen (*f.c.t*); *st*, sternum; *zy*, articular process of the arch (zygapophysis). (From Wiedersheim's *Structure of Man*.)

it is the first rib alone which is so attached. As a rule, to which the Whales mentioned are again an exception, the rib is divided into at least two regions—the vertebral portion which is always ossified, and the sternal moiety which is usually cartilaginous. This is, however, often very short in the first rib. They are, however, ossified in the Armadillos and in some other animals. Between the vertebral and sternal portions an intermediate tract is separated off and ossified in the Monotremata. The ribs of existing mammals belong only to the dorsal region of the vertebral column, but there are traces of lumbar ribs and also of cervical ribs. In the Monotremata, indeed, these latter

are persistently free for a very long period, and in some cases never become ankylosed with their vertebrae. But it should be noted that in this group there is no approximation to the state of affairs which exists in many lower Vertebrates, where there is a gradual transition between the ribs of the cervical and those of the dorsal region of the vertebral column; for that of the seventh ribs in Monotremes is smaller than those which precede it.

The Sternum.—All the Mammalia so far as is known possess a sternum. This is the bone, or series of bones (sternebrae), which lies upon the ventral surface of the chest, and to which the ribs are attached below. The development of the sternum has been shown to take place from the fusion of the ribs below into two lateral bands, one on each side; the approximation of these bands forms the single and unpaired sternum of most mammals. Very considerable traces, however, of the paired state of the sternal bones often exist; thus in the Sperm Whale the first piece of the sternum is divided into two by a longitudinal division, and the second piece is longitudinally grooved. The development of the sternum out of the fused ends of ribs is shown in a more complete condition in some specis of *Manis* than in many other mammals. Thus in *M. tricuspis* the last ribs of those which are attached to the sternum are completely fused together into a single piece on each side.[1] As a general rule the last ribs which come into relation with the sternum do so only in an imperfect way, being simply firmly attached at their sides to, but not fused with, the last ribs which are definitely articulated with the sternum. Contrary to what is found in lower Verte-

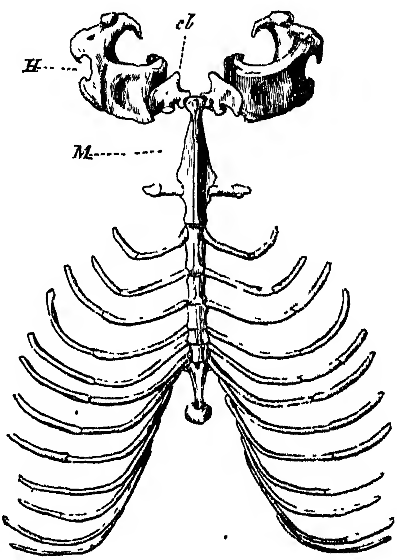

FIG. 18.—Sternum and sternal ribs of the Common Mole (*Talpa europaea*), with the clavicles (*cl*) and humeri (*H*); *M*, manubrium sterni. Nat. size. (From Flower's *Osteology*.)

[1] Ehler's *Zool. Miscellen.* i. 1894.

brates, the sternum of the Mammalia consists of a series of pieces, as many as eight or nine or even sixteen in *Choloepus,* of which the first is called the manubrium sterni, and the last the ensiform cartilage, xiphisternum, or xiphoid process. The latter often remains largely cartilaginous throughout life; in fact this is generally but not universally the case with that part of the breastbone. The most extraordinary modification of the xiphoid process is seen in the African species of the genus *Manis,* where it diverges into two long cartilages, which run back to the pelvis and then, curving round, run forwards and fuse together in the middle line anteriorly. These processes serve for the attachment of certain tongue-muscles. They were looked upon by Professor Parker as the equivalents of the "abdominal ribs" of reptiles elsewhere non-existent among mammals. This view is not, however, usually held. The manubrium sterni is often keeled in the middle line below; this is so with the Bats, which thus approach the birds, and probably for the same reason, *i.e.* the need of an enlarged origin for the pectoral muscle, which is concerned in the movements of flight. In many forms this part of the sternum is much broader than the pieces which follow; this is so with the Viscacha. In the Pig the precise reverse is seen, the manubrium being narrower than the rest of the sternal boneless. It will be noticed, however, that in this and similar cases there are no clavicles. Ribs are attached between the successive pieces of the sternum. When the sternum is reduced, as it is in the Cetacea and in the Sirenia, it is the intermediate part of the series of bones which becomes abbreviated or vanishes. The Sperm Whale has only a manubrium sterni and a following piece belonging to the mesosternum. It is fair to say that the xiphoid process and the rest of the sternum have disappeared, since among the Toothed Whales a progressive shortening of the sternum can be seen. In the Whalebone Whales the sternum is still further reduced; the manubrium is alone left, and to it are attached but a single pair of ribs. In *Balæna,* however, a rudimentary

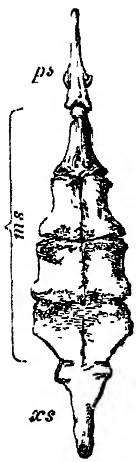

FIG. 19.—Sternum of the Pig (*Sus scrofa*). × ¼. *ms*, Mesosternum; *ps*, presternum; *xs*, xiphisternum. (From Flower's *Osteology*.)

piece, apparently comparable to a xiphoid process, has been detected.

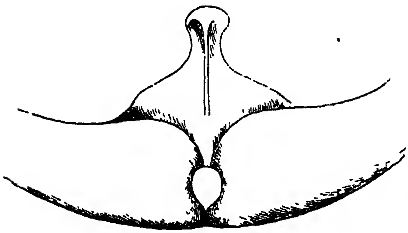

FIG 20.—Sternum of Rudolphi's Whale (*Balaenoptera borealis*), showing its relation to the inferior extremities of the first pair of ribs. $\times \frac{1}{16}$. (From Flower's *Osteology*)

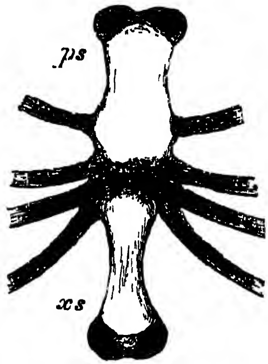

FIG. 21.—Sternum of a young Dugong (*Halicore indicus*). $\times \frac{1}{2}$. From a specimen in the Leyden Museum. *ps*, Presternum, *xs*, xiphisternum. (From Flower's *Osteology*).

From the instances which have been described, as well as from the mode of development of the sternum and from the number of free ribs, *i.e* ribs which are not attached to it, it would seem that the sternum has undergone a considerable reduction in its size. This reduction may be possibly accounted for by the need for respiratory activity, which is clearly increased by a less-marked fixity of the walls of the thoracic cavity. In the case of the Whales one can hardly help coming to that conclusion. The arrangement in the Monotremata does not, however, point in the same direction; for these animals are precisely like the higher Mammalia in the reduction of the sternum and of the number of ribs which reach it.

The Episternum.—The Mammalia are as a rule to be distinguished from lower Vertebrates by the absence of an episternum, or interclavicle as it is also called. In the Monotremata, however, there is a large T-shaped bone which does not overlie the sternum as in reptiles, but is anterior to it. The relations of this bone to the clavicles seem to leave no doubt that it is the equivalent of the Lacertilian interclavicle or episternum. The Monotremata are not, however, the only mammals in which this structure is to be seen. The Mole in the embryonic condition is

provided with pieces of bone which overlie the manubrium sterni

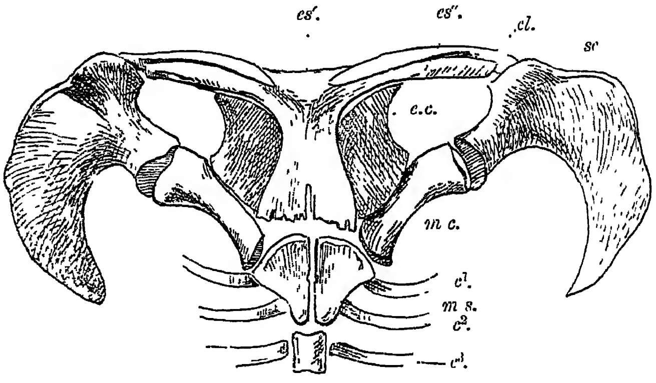

FIG. 22.—Shoulder girdle of *Ornithorhynchus*. c^1, c^2, c^3, First, second, third ribs, *cl*, clavicle; *e.c*, epicoracoid, *es'* and *es''*, interclavicle (episternum); *m.c*, metacoracoid; *m s*, manubrium sterni; *sc*, scapula; *st*, sternebra (From Wiedersheim's *Structure of Man.*)

and are attached to the clavicles, and are no doubt to be regarded as the same structure. Probably in many mammals the manubrium will be found to be partly made up of corresponding rudiments. In any case, vestiges of an episternum in the shape of two minute ossicles have been discovered in Man, lying in front of the manubrium. They have been termed ossa suprasternalia. In Man and in the Mole the paired nature of the episternum is clearly apparent. It has been suggested that this structure in its entirety belongs to the clavicles, just as the sternum belongs to the ribs; *i.e.* that it formed out of the approximated and fused ends of the clavicles. Dr. Mivart[1] figured a good many years since a pair of ossicles in *Mycetes*, lying in one case between the ends of the clavicles and the manubrium sterni, and in another example anterior to the ventral ends of the clavicles. Gegenbaur has figured a

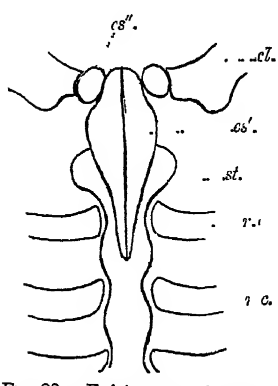

FIG. 23.—Episternum of an embryo Mole. (After A. Gotte.) *cl*, Clavicle, *es'*, central portion of the episternum; *es''*, lateral portion of the same; *r.c*, costal ribs; *st*, sternum. (The figure was constructed from two consecutive horizontal sections.) (From Wiedersheim's *Structure of Man.*)

[1] *Proc. Zool. Soc.* 1865, p. 567.

pair of similar bones in the Hamster.[1] It is possible that these are to be referred to the same category. It has also been

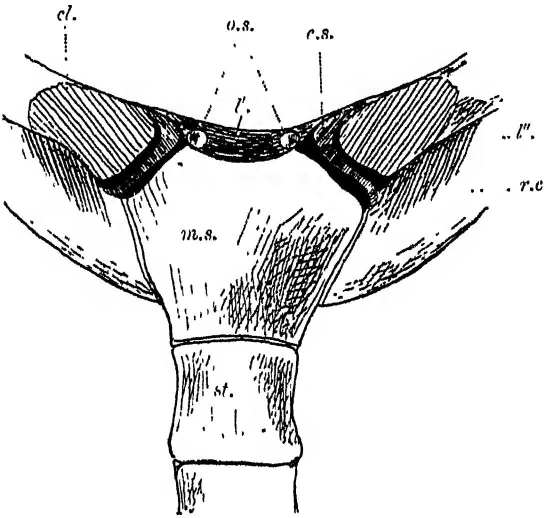

FIG. 24.—Episternal vestiges in Man. *cl*, Clavicle, sawn through; *es*, "episternum" (sterno-clavicular cartilage); *l'*, interclavicular ligament, *l''*, costo-clavicular ligament; *m.s*, manubrium sterni; *o.s*, ossa suprasternalia; *r.c*, first rib; *st*, sternum. (From Wiedersheim's *Structure of Man*)

suggested that these supposed episternal rudiments are the vestiges of a pair of cervical ribs.

The Pectoral Girdle.—The skeleton by which the fore-limb is connected with the trunk is known as the Pectoral Girdle. The main part of this girdle is formed by the large scapula, or blade-bone as it is often termed. The coracoidal elements will be dealt with later. The scapula is not firmly connected with the backbone; it is attached merely by muscles, thus presenting a great difference from the corresponding pelvic girdle. The reason for this difference is not easy to understand. On the one hand it may be pointed out that in all running animals at any rate there is a greater need for the fixation in a particularly firm way of the hind-limbs; but, again, in the climbing creatures both limbs would, one might suppose, be bettered by a firm fixation. It must be remembered, however, that in the latter case the same result is at least partly brought about by a well-developed clavicle, which fixes the girdle to the sternum and so to the vertebral column by means of the ribs.

Broadly speaking, too, the fore-limbs require a greater freedom and variety of movement than the hind-limbs, which are supports

[1] *Vergl. Anat. der Wirbelth.* Leipzig, 1898, p. 497.

for or serve to push along the rapidly-moving body. Stronger fixation is therefore a greater necessity posteriorly than anteriorly. In any case, whatever the explanation, this important difference exists.

The shoulder-blade of mammals is as a rule a much-flattened bone with a ridge on the outer surface known as the spine;

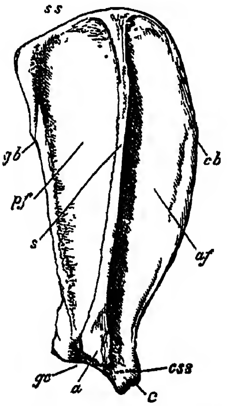

FIG. 25.—Right scapula of Dog (*Canis familiaris*). $\times \frac{1}{4}$. *a*, Acromion, *af*, prescapular fossa; *c*, coracoid; *cb*, coracoid or anterior border; *css*, indicates the position of the coraco-scapular suture, obliterated in adult animals by the complete ankylosis of the two bones; *gb*, glenoid or posterior border; *gc*, glenoid cavity; *pf*, postscapular fossa; *s*, spine; *ss*, suprascapular border. (From Flower's *Osteology*.)

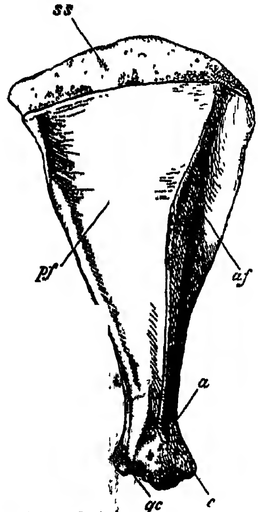

FIG. 26.—Right scapula of Red Deer (*Cervus elaphus*). ×[illegible]. *a*, Acromion; *af*, anterior or prescapular fossa; *c*, coracoid; *gc*, glenoid cavity; *pf*, postscapular fossa; *ss*, partially ossified suprascapular border. (From Flower's *Osteology*.)

this ridge ends in a freely-projecting process, the acromion, from which a branch often arises known as the metacromion. This gives a bifurcate appearance to the end of the ridge. The spine is less developed and the sc[illegible]ower in such animals as the Dog and the Deer w[illegible]n, and whose fore-limbs therefore are not endowed [illegible] complexity of movement seen, for instance, in the A[illegible]

It has been pointed out that [illegible]ies in front of

the spine, the prescapular lamina, is most extensively developed in such animals as perform complex movements with the fore-limbs The Sea Lion and the Great Anteater are cited by Professor G. B. Howes as examples of this preponderance of the anterior portion of the scapula over that which lies behind the spine. The general shape of the scapula varies considerably among the different orders of mammals; but it always presents the characters mentioned, which are nowhere seen among the Sauropsida except among certain Anomodonts, which will be duly referred to (see p. 90). The most conspicuous divergences from the normal are to be found in the Cetacea and the Monotremata. In the former the acromion is approximated so nearly to the anterior border of the blade-bone that the prescapular fossa is reduced to a very small area; and in *Platanista* the acromion actually coincides with the anterior border, so that that fossa actually disappears. In the Whales, too, the scapula is as a rule very broad, especially above; it has frequently a fan-like contour. In the Monotremata the acromion also coincides with the anterior border of the scapula; but the sameness of appearance which it thus presents (in this feature) to the Cetacean scapula is appar-

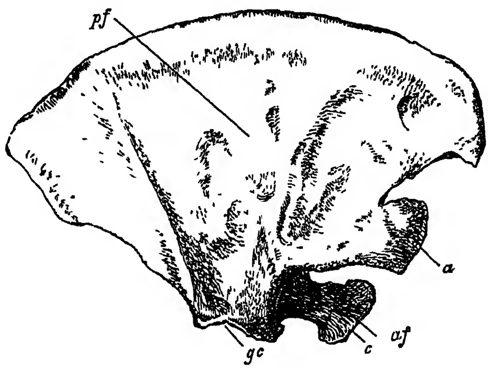

FIG. 27.—Right scapula of Dolphin (*Tursiops tursio*). × ⅛. *a*, Acromion; *af*, prescapular fossa; *c*, coracoid; *gc*, glenoid cavity; *pf*, postscapular fossa. (From Flower's *Osteology*.)

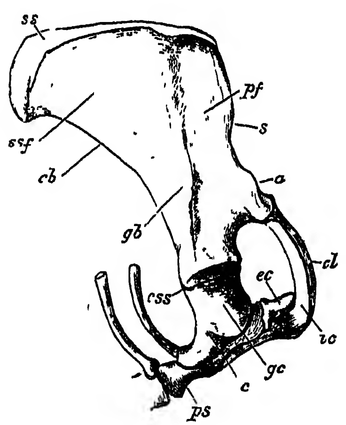

FIG. 28.—Side view of right half of shoulder girdle of a young Echidna (*Echidna hystrix*). × ⅔. *a*, Acromion; *c*, coracoid, *cb*, coracoid border, *cl*, clavicle; *css*, coraco-scapular suture; *ec*, epicoracoid; *gb*, glenoid border; *gc*, glenoid cavity; *ic*, interclavicle; *pf*, post-scapular fossa; *ps*, presternum; *s*, spine; *ss*, suprascapular epiphysis; *ssf*, subscapular fossa. (From Flower's *Osteology*.)

ently not due to real resemblance. What has happened in the Monotremata is, that the prescapular fossa is so enormously expanded that it occupies the whole of the inner side of the blade-bone, while the subscapular fossa which, so to speak, should occupy that situation, has been thus pushed round to the front, where it is divided from the postscapular fossa by a slight ridge only.

The clavicle is a bone which varies much in mammals. It is sometimes indeed, as in the Ungulata, entirely absent; in other forms it shows varying degrees of retrocession in importance; it is only in climbing, burrowing, digging, and flying mammals that it is really well developed.

In the higher Mammalia the coracoid[1] is present, but does not reach the sternum as in the Monotremata. It is known to human anatomists as the coracoid process of the scapula. It has been found, however, by Professor Howes[2] and others, that this process really consists of two separate centres of ossification, forming two separate bonelets, which in the adult become firmly ankylosed to each other and to the scapula. These two separate bones have been met with in the embryo of *Lepus*, *Sciurus*, and the young of various other mammals belonging to very diverse orders, such as Edentates and Primates. The separation even occasionally persists in the adult. The question is, What is the relation of these bonelets to the coracoid of the Monotremata and to the corresponding regions of reptiles? Professor Howes terms the lower patch of bone the metacoracoid and the upper the epicoracoid;

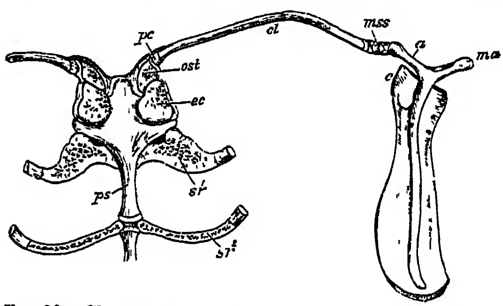

FIG 29.—Shoulder girdle, with upper end of sternum (inner surface) of Shrew (*Sorex*), after Parker. × 7. *a*, Acromion; *c*, coracoid; *cl*, clavicle; *ec*, partially ossified "epicoracoid" of Parker, or rudiment of the sternal extremity of the coracoid; *ma*, metacromial process; *mss*, ossified "mesoscapular segment"; *ost*, omosternum; *pc*, rudiment of precoracoid (Parker); *ps*, presternum; *sr*[1], first sternal rib; *sr*[2], second sternal rib. (From Flower's *Osteology*.)

[1] To this category are perhaps to be referred cartilaginous pieces occurring in the Rabbit, *Mus* and *Sorex* (see Fig. 29 above).

[2] "On the Coracoid of the Terrestrial Vertebrates," *P.Z.S.* 1893, p. 585.

the former is alone concerned with the glenoid cavity. It must therefore, one would suppose, correspond to the "coracoid" of the Monotremata, while the upper piece of bone is the epicoracoid process of that mammal. The Mammalia, therefore, higher as well as lower, differ from the reptiles in that the coracoid is formed of two bones, the exceptions being, among some other extinct forms, certain of the Anomodontia, a group which it will be recollected is the nearest of all reptiles to the mammals.

The Fore-limb.—The humerus is of varying length among mammals. A feature which it sometimes shares with the humerus

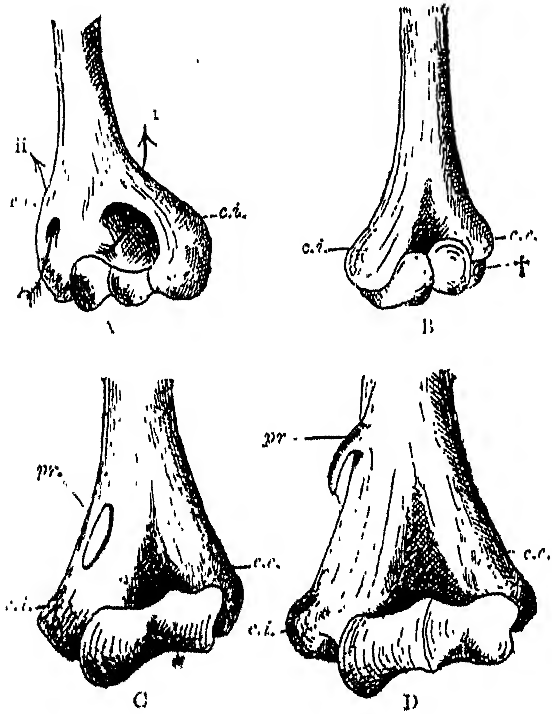

Fig. 30.—Distal extremity of the humerus to show Epicondylar Foramina. A, In *Hatteria*. B, in a Lizard (*Lacerta ocellata*); C, in the Domestic Cat; D, in Man. *c.e*, External condyle; *c.i*, internal condyle. In A the two foramina are developed (at *i*, the entepicondylar; at *ii*, the ectepicondylar). The only canal (†) present in the Lizard (B) is on the external ulnar side, in the cartilaginous distal extremity. In Man (D) an entepicondylar process (*pr*) is sometimes developed and continued as a fibrous band. (From Wiedersheim's *Anatomy of Man*.)

of lower forms is the presence of an entepicondylar foramen, a defect of ossification situated above the inner condyle of that bone which transmits a nerve. The same foramen and an additional ectepicondylar foramen are found in the ancient reptilian type *Hatteria* (*Sphenodon*); it occurs also in the Anomodont reptiles. It is as a rule only the lower forms among mammals which show this foramen; thus it is present in the Mole and absent in the

Horse The fact that it is occasionally met with in Man is an additional proof of the, in many respects, ancient structure of the highest type of Primate.

The radius and the ulna, which together constitute the fore-arm, are both present in a large number of mammals, but the ulna tends to vanish in the purely walking and digitigrade Ungulates, being present, however, in the more ancient forms of these Ungulates. In Man and in many other mammals the radius can be moved from its normal position and crossed over the ulna; this movement of pronation has been permanently fixed in the Elephant, where the bones are crossed but cannot be altered in position by the contractions of any muscles. Other types agree with the Elephant in this fixation of the two bones.

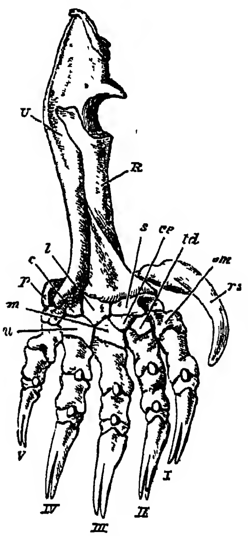

FIG. 31 —Bones of fore-arm and manus of Mole (*Talpa europaea*). × 2. *c*, Cuneiform; *ce*, centrale, *l*, lunar; *m*, magnum; *p*, pisiform; *R*, radius; *rs*, radial sesamoid (falciform); *s*, scaphoid, *td*, trapezoid, *tm*, trapezium; *U*, ulna; *u*, unciform; *I-V*, the digits. (From Flower's *Osteology*)

The bones of the wrist show great variation among mammals. The greatest number present are to be seen in such a type as the Mole. Here we have a proximal row, consisting of the scaphoid, lunar, cuneiform, and pisiform, which are arranged in their proper order, beginning with that on the radial side of the limb, that side which bears the first digit. A second row articulates proximally with these bonelets and distally with the metacarpals; the bones composing it are, mentioning them in the same order, trapezium, trapezoid, centrale, magnum, unciform.

The centrale does not, however, really belong to the distal carpal row, and is as a rule situated in the middle of the carpus away from articulation with the metacarpals. It is a bone which is not commonly present in the mammalian hand, but is present in various lower forms, such as the Beaver and Hyrax. It also occurs in such high types as the majority of Monkeys; it is to be found in the Human foetal carpus. Many extinct forms possessed a separate centrale. Its importance in the formation of the interlocking condition of the Ungulate foot is referred to later,

on p. 196. The only mammal which appears to have the proper five bones in the distal row of the carpus corresponding to the five metacarpals is *Hyperoodon,* where this state of affairs at least occasionally occurs. The final bone of that series, the unciform, seems to represent two bones fused. Very often the carpus is reduced by the fusion of certain of the carpal bones; thus among the Carnivora it is usual for the scaphoid and the lunar to be fused. It is interestingly significant that these bones retain their distinctness in the ancestral Creodonts. In many Ungulates the trapezium vanishes. The reduction of the toes in fact implies a reduction of the separate elements of the carpus.

As to the digits of the mammalian hand, the greatest number is five, the various supplementary bonelets known as prepollex and postminimus being, it is now generally held, merely supplementary ossifications not representing the rudiments of pre-existing fingers. They may, however, bear claws.[1] The number of phalanges which follow upon the metacarpals is almost constantly three in the mammals, excepting for the thumb, which has only two. This is highly characteristic of the group as opposed to reptiles and birds, and the increase in the number of these bones in the Whales and to a very faint degree in the Sirenia is a special reduplication, which will be mentioned when those animals are treated of.

The Pelvic Girdle.—The pelvic girdle or hip girdle is the combined set of bones which are attached on the one hand to the sacrum and on the other articulate with the hind-limb. Four distinct elements are to be recognised in each "os innominatum," the name given to the conjoined bones of each half of the entire pelvis. These are:—the ilium, which articulates with the sacrum, the ischium, which is posterior; the pubis, which is anterior; and finally, a small element, the cotyloid, which lies within the acetabular cavity where the femur articulates. The epipubes of the Monotreme and the Marsupial are dealt with elsewhere (see p. 116) as they are peculiar to those groups.

Professor Huxley pointed out many years since that while the Eutherian Mammalia differ from the reptiles in the fact that the axis of the ilium lies at a less angle with that of the sacrum,

[1] Horny matter is apt to be formed upon extremities; instances which are well known are the "claws" upon the tail of the Lion and Leopard and the Kangaroo *Onychogale* For an account of the first see *Proc Zool Soc* 1832, p 146

Ornithorhynchus comes nearest to the reptile in the fact that this axis is nearly at right angles to that of the sacrum. It is particularly interesting to find that this peculiarity of *Ornithorhynchus* is only acquired later in life, and that the pelvis of the foetus conforms in these angles to the adults of other mammalian groups. In any case, the backward rotation of the pelvis is a mammalian characteristic, and it is most nearly approached among reptiles by the extinct Anomodontia, whose affinities to mammals will be dealt with on a later page (p. 90). Another peculiarity of the mammalian pelvis appears to be the cotyloid bone already referred to. In the Rabbit this bone completely shuts out the pubis from any share in the acetabular cavity; later it ankyloses with that bone. In *Ornithorhynchus* the cotyloid or os acetabuli is a larger element of the girdle than is the pubis. In other mammals, therefore, it seems to be a rudimentary structure. But it seems to be a bone peculiar to and thus distinctive of the mammals as compared with other vertebrates. The acetabular cavity is perforated in *Echidna* as in birds; but in certain Rodents the same region is very thin and only closed by membrane, as in *Circolabes villosus*.

The number and the arrangement of the bones in the **hind-limb** correspond exactly to those of the fore-limb. The femur, which corresponds to the humerus, shows some diversities of form. The neck, which follows upon the almost globular head, the surface of articulation to the acetabular cavity of the pelvis, has two roughened areas or tuberosities for the insertions of muscles. A third such area, known as the third trochanter, is present or absent as the case may be, and its presence or absence is of systematic import. As a general rule the thigh-bones of the ancient types of mammals are smoother and less roughened by the presence of these three trochanters than in their modern representatives. The radius and the ulna are represented in the hind-leg by the tibia and the fibula. These bones are not crossed, and do not allow of rotation as is the case with the radius and the ulna. In Ungulate animals there is the same tendency to the shortening and rudimentary character of the fibula that occurs in the case of the ulna, but it is more marked. It has been shown in tracing the history of fossil Ungulates that the hind-limbs in their degree of degeneration are as a rule ahead of the fore-limbs. This is natural when we reflect that

the hind-limbs must have preceded the fore-limbs in their thorough adaptation to the cursorial mode of progression. In the Mammalia the ankle-joint is always what is termed cruro-tarsal, *i.e.* between the ends of the limb-bones and the proximal row of tarsals; not in the middle of the tarsus as in some Sauropsida (reptiles and birds). The bones of the ankle are much like those of the hand; but there are never more than two bones in the proximal row, which are the astragalus and the calcaneum. The former is perhaps to be looked upon as the equivalent of the cuneiform and lunar together. But the views as to the homologies of the tarsal bones differ widely. Below these is the navicular, regarded as a centrale. The distal row of the tarsus has four bones, three cuneiforms and a cuboid. Reduction is effected by the soldering together of two cuneiforms as in the Horse, by the fusion of the navicular and cuboid as in the Deer. No mammal has more than five toes, and the number tends to become reduced in cursorial animals (Rodents, Ungulates, Kangaroos).

FIG. 32.—Anterior aspect of right femur of Rhinoceros (*Rhinoceros indicus*). × [illegible]. *h*, Head; *t*, great trochanter; *t′*, third trochanter. (From Flower's *Osteology*.)

Teeth.—The teeth of the Mammalia[1] differ from those of other vertebrated animals in a number of important points. These, however, entirely concern the form of the adult teeth, their position in the mouth, and the succession of the series of teeth. Developmentally and histologically there are no fundamental divergences from the teeth of vertebrates lower in the scale.

In mammals, as for example in the Dog, the teeth consist of three kinds of tissue—the enamel, the dentine, and the cement. The enamel is derived from the epidermis of the mouth cavity, and the two remaining constituents from the underlying dermis. The teeth originate quite independently of the jaws, with which they are later so intimately connected; the independence of origin being one of the facts upon which the current theory

[1] Cf. Tomes, *A Manual of Dental Anatomy*, 5th ed. London, 1898.

of the nature of teeth is founded. It has been pointed out that the scales of the Elasmobranch fishes, consist of a cap of enamel upon a base of dentine, the former being derived from the epidermis and modelled upon a papilla of the dermis whose cells secrete the dentine. The fact that similar structures arise within the mouth (*i.e.* the teeth) is explicable when it is remembered that the mouth itself is a late invagination from the outside of the body, and that therefore the retention by its tissues of the capacity to produce such structures is not remarkable.

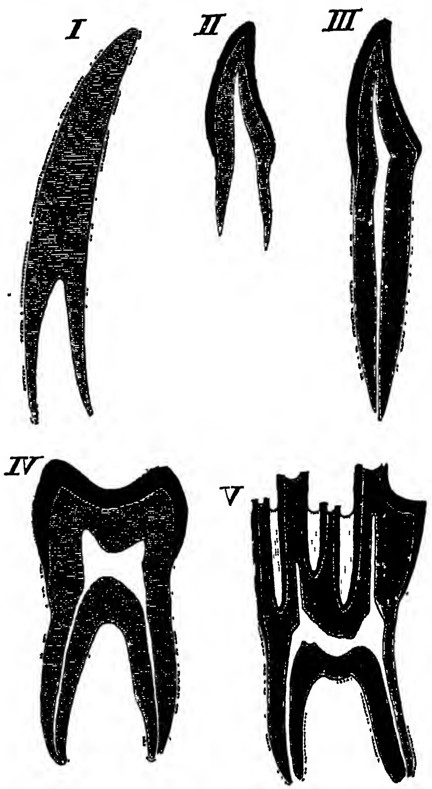

FIG. 33.—Diagrammatic sections of various forms of teeth *I*, Incisor or tusk of Elephant, with pulp cavity persistently open at base, *II*, Human incisor during development, with root imperfectly formed, and pulp cavity widely open at base; *III*, completely formed Human incisor, with pulp cavity opening by a contracted aperture at base of root; *IV*, Human molar with broad crown and two roots; *V*, molar of the Ox, with the enamel covering the crown deeply folded, and the depressions filled up with cement; the surface is worn by use, otherwise the enamel coating would be continuous at the top of the ridges. In all the figures the enamel is black, the pulp white; the dentine represented by horizontal lines, and the cement by dots. (After Flower and Lydekker.)

The relations of the three constituents of the tooth in its simplest form is shown in the accompanying diagram, where the intimate structure of the enamel, dentine, and cement (or crusta petrosa as it is sometimes called) is not indicated. The latter has the closest resemblance to bone. The dentine is traversed by fine canals which run parallel to each other and anastomose here and there. The enamel is formed of long prismatic fibres, and is excessively hard in structure, containing less animal matter than the other tooth tissues. To this fact is frequently

due the complicated patterns upon the grinding teeth of Ungulates, which are produced by the wearing away of the dentine and the cement, and the resistance of the enamel.

The centre of the tooth papilla remains soft and forms the pulp of the tooth, which is continuous with the underlying tissues of the gum by a fine canal or a wide cavity as the case may be. In teeth which persistently grow throughout the lifetime of the animal, as for example the incisors of the Rodents, there is a wide intercommunication between the cavity of the tooth and the tissues of the gum; only a narrow canal exists in, for instance, the teeth of Man, and in fact in the vast majority of cases. The three constituents of the typical teeth are not, however, found in all mammals; the layer which is sometimes wanting is the enamel. This is the case with most Edentates, but the interesting discovery has been made (by Tomes) that in the Armadillo there is a downgrowth of the epidermis similar to that which forms the enamel in other mammals, a rudimentary "enamel organ."

Teeth are present in nearly all the Mammalia; and where they are absent there is frequently some evidence to show that the loss is a recent one. The Whalebone Whales, the Monotremata, *Manis*, and the American Anteaters among the Edentata are devoid of teeth in the adult state. In several of these instances, however, more or less rudimentary teeth have been found, which either never cut the gums or else become lost early in life. The latter is the case with *Ornithorhynchus*, where there are teeth up to maturity (see p. 113). Kukenthal has found germs of teeth in Whales, and Röse in the Oriental *Manis*. The loss of the teeth in these cases seems to have some relation to the nature of the food. In ant-eating mammals, as in the Anteaters and *Echidna*, the ants are licked up by the long and viscid tongue, and require no mastication. Yet it must be remembered that *Orycteropus* is also an anteater, like the Marsupial *Myrmecobius*, both of which genera have teeth.

The first of the essential peculiarities of the mammalian teeth as compared with those of other vertebrates concerns the position of the teeth in the mouth. There is no undoubted mammal extinct or living in which the teeth are attached to any bones other than the dentary, the maxilla, and the pre-

maxilla. There are no vomerine, palatine, or pterygoid teeth, such as are met with in Amphibia and Reptilia.

The other peculiarities of the mammalian teeth, though true of the great majority of cases, are none of them absolutely universal.

But it is necessary to go into the subject at some length on account of the great importance which has been laid upon the teeth in deciding questions of relationship; moreover, largely no doubt on account of their hardness and imperishability, our knowledge of certain extinct forms of Mammalia is entirely based upon a few scattered teeth; while of some others, notably of the Triassic and Jurassic genera, there is not a great deal of evidence except that which is furnished by the teeth. Indeed the important place which odontography holds in comparative anatomy is from many points of view to be regretted, though inevitable. "In hardly any other system of organs of vertebrated animals," remarks Dr. Leche, "is there so much danger of confounding the results of convergence of development with true homologies, for scarcely any other set of organs is less conservative and more completely subservient to the lightest impulse from without." Affinities as indicated by the teeth are sometimes in direct contradiction to those afforded by other organs; or, as in the case of the simple Toothed Whales, no evidence of any kind is forthcoming. Dr. Leche has pointed out that, judged merely from its teeth, *Arctictis* would be referred to the Raccoons, though it is really a Viverrid; while *Bassariscus*, which Sir W. Flower showed to be a Raccoon, is in its teeth a Viverrid. Mr. Bateson has been obliged to hamper the subject with another difficulty.

In dealing with the variations of teeth,[1] Mr. Bateson has brought together an immense number of facts, which tend to prove that the variability of these structures is much greater than had been previously recognised; that this variability is often symmetrical; and that in some animals, as in "*Canis cancrivorus*, a South American fox, the majority showed some abnormality." When we learn from Mr. Bateson that "of *Felis fontanieri*, an aberrant leopard, two skulls only are known, both showing dental abnormalities," it seems dangerous to rear too lofty a superstructure upon a single fossil jaw. It must be noted too that,

[1] *Materials for the Study of Variation*, London, 1894.

contrary to the prevailing superstition, it is not domestic animals which show the greatest amount of tooth variation. As to special homologies between tooth and tooth, with which we shall deal on a later page, Mr. Bateson has urged almost insuperable difficulties.

The teeth of the Mammalia are almost without exception "heterodont," *i.e.* they show differences of structure in different

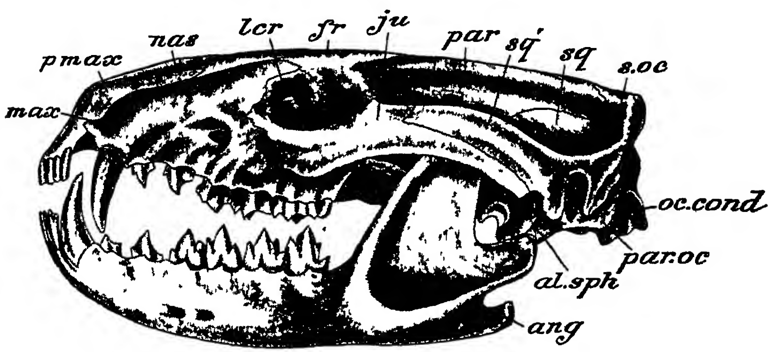

FIG 34.—Skull of *Dasyurus* (lateral view). *al.sph*, Alisphenoid; *ang*, angular process of mandible; *fr*, frontal; *ju*, jugal; *lcr*, lachrymal; *max*, maxilla; *nas*, nasal; *oc cond*, occipital condyle, *par*, parietal; *par.oc*, paroccipital process; *p.max*, premaxilla; *s.oc*, supraoccipital; *sq*, squamosal, *sq'*, zygomatic process of squamosal. (From Parker and Haswell's *Zoology*)

parts of the mouth. As a general rule, teeth can be grouped into cutting incisors, sharp conical canines, and molars, with a

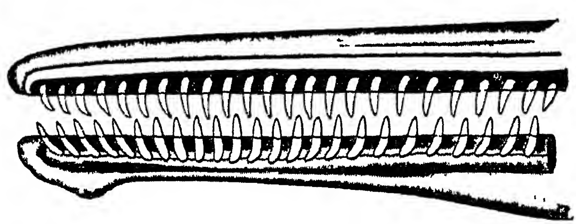

FIG. 35.—Upper and lower teeth of one side of the mouth of a Dolphin (*Lagenorhynchus*), illustrating the homodont type of dentition in a mammal. (After Flower and Lydekker)

surface which is in the majority of cases suited for grinding. In this they contrast with the majority of the lower vertebrates, where the teeth are "homodont" (or, better, *homoeodont*), *i.e.* all more or less similar and not fitted by change of form to perform different duties. But there are exceptions on both sides. In

the Toothed Whales the teeth are homodont, as they are in the frog and in most reptiles; on the other hand, some of the remarkable reptiles belonging to Professor Huxley's order of the Anomodontia have distinct canines, and show other differentiations in their teeth.

A second characteristic of the mammalian dentition is the limited number of the teeth, which rarely exceeds fifty-four. Here again the Toothed Whales are an exception, the number of their teeth being as great as in many reptiles. In the Mammalia the number of the teeth is fixed (excepting of course for abnormalities), while in reptiles there is frequently no precise normal. Two regions may be distinguished in every tooth—the crown and the root; the latter, as its name denotes, is imbedded in the gum, while the crown is the freely-projecting summit of the tooth. The varying proportions of these two regions of the tooth enables us to divide teeth into two series—the brachyodont and the hypselodont; in the latter the crown is developed at the expense of the root, which is small; the hypselodont tooth is one that grows from a persistent pulp or, at any rate, one that is long open. Brachyodont teeth on the contrary have narrow canals running into the dentine. The primitive form of the tooth seems undoubtedly to be a conical single-rooted tooth, such as is now preserved in the Toothed Whales and in the canine teeth of nearly all animals. The development of the teeth, that is, the simple bell-shaped form of the enamel organ, seems to go some way towards proving this; but it is quite another question whether we can fairly regard the Whales as having retained this early form of tooth. In their case the simplification, as is so often the case where organs are simplified, seems to be rather degeneration than retention of primitive characters. But this is a matter which must be deferred for the present.

The incisor teeth are generally of simple structure and nearly always single rooted. In the Rodents, in the extinct Tillodontia and in Diprotodont Marsupials, they have grown large, and, as has been already stated, they increase in size continuously from the growing pulp. These teeth have a layer of enamel only on the anterior face, which keeps a sharp chisel-like edge upon them by reason of the fact that the harder enamel is worn away more slowly than the comparatively soft dentine. The

"horn" of the Narwhal is another modification of an incisor, as are the tusks of Elephants. Among the Lemurs the incisors are denticulate, and serve to clean the fur in a comb-like fashion. This is markedly the case in *Galeopithecus*. The incisors are sometimes totally absent, as in the Sloths, sometimes partially absent, as in many Artiodactyles, where the lower incisors bite against a callous pad in the upper jaw, in which no trace of incisors has been found.

Canine teeth are present in the majority of mammals, but are absent without a single exception from the jaws of the Rodentia. The canine tooth of the upper jaw is that tooth which comes immediately after the suture dividing the premaxillary from the maxillary bone. The canines are as a rule simple conical teeth, with but a single root; indeed they resemble what we may presume to have been the first kind of tooth developed in mammals. In this they resemble also as a general rule the foregoing incisors. But instances are known where the canines are implanted by two roots. This is to be seen in *Triconodon*, in the pig *Hyotherium*, in the Mole and some other Insectivores, and in *Galeopithecus*, where the incisors also may be thus implanted in the jaw. Furthermore, the simple condition of the crown of the tooth may be departed from. This is the case with a Fruit Bat belonging to the genus *Pteralopex*. In the more primitive Mammalia it is common to find no great difference between the canines and incisors; such is the case with the early Ungulate types of Eocene times, such as *Xiphodon*. In modern mammals, however, especially among the Carnivora, the canines tend to become larger and stronger than the incisors, and in some of the Cats and in the Walrus these teeth are represented by enormous offensive tusks. It is not rare for the canines of male animals to be larger than those of their mates. There are also cases such as the Musk-deer and the Kanchil where the male alone possesses these teeth, but only in the upper jaw. The teeth which follow the canines are known as the grinders or cheek teeth, or more technically as premolars and molars. These two latter terms separate teeth which arise at different periods, and their use will be explained later. In the meantime it may be pointed out that the cheek teeth are the teeth which show the greatest amount of variation in their structure; this is shown by the number and variety of the cusps in which

the biting surface ends. The grinding teeth vary from simple one-cusped teeth, precisely like canines, to teeth with an enormous number of separate tubercles. In the former case it is hard to distinguish between incisors, canines, and cheek teeth in the lower jaw, where no suture separates the bone. Moreover it is quite common for the first cheek tooth in the lower jaw to have the characters of a canine, while the true canine approximates in its form to the antecedent incisors. This is so, for instance, with the Lemurs, where the first premolar is caniniform, and the canine shares in the curious procumbent attitude which distinguishes the lower incisors of many of these animals.

A variable number of the anterior cheek teeth may be little more than simple conical teeth; but the rest of the set are commonly more complicated. No definite laws can be laid down as to the complication of the posterior as compared with the anterior set. Broadly speaking, it is purely herbivorous creatures in which the least difference can be detected at the two extremities, and which are at the same time the most elaborately decorated with tubercles and ridges. The converse is true that in purely carnivorous animals, including insect- and fish-eating forms, there is the greatest difference between the anterior set of grinding teeth and those which follow. In these two respects such animals as a Lemur and a Rhinoceros occupy the extremes. Furthermore, it may be said that omnivorous creatures lie, as their diet would suggest, in an intermediate position. Generally speaking, when there is a marked difference between the first premolar and molars at the end of the series, there is a gradual approximation in structure of a progressive kind. The tubercles become more numerous in successive teeth; but the corollary which is apparently deducible from this, *i.e.* that the last molar is the most elaborate of the series, is by no means always true. The last cheek tooth indeed is often degenerate. On the other hand, it is very markedly the largest of the series in such diverse types as the Elephant, the hog *Phacochoerus*, and the Rodent *Hydrochoerus*. It is a rule that the cheek teeth of the upper jaw are more complicated than the corresponding teeth of the lower jaw.

The structure of the cheek teeth is very diverse among the Mammalia. Broadly, two types are to be recognised. There are

teeth in which the grinding surface is raised into a series of two, to many, tubercles sharper or blunter as the case may be;—sharper and fewer at the same time in carnivorous and especially in insectivorous types, more abundant in omnivorous animals. To this form of tooth the term "bunodont" is applied. There is no doubt that this is the earliest type of tooth; but whether the fewer or the more cusped condition is the primitive one is a question that is reserved for consideration at the end of the present chapter. The other type of grinding tooth is known as "lophodont." This is exemplified by such types as the Perissodactyla and Ungulates generally, and by the Rodents. The tooth is traversed by ridges which have generally a transverse direction to the long axis of the jaw in which the tooth lies. The ridges

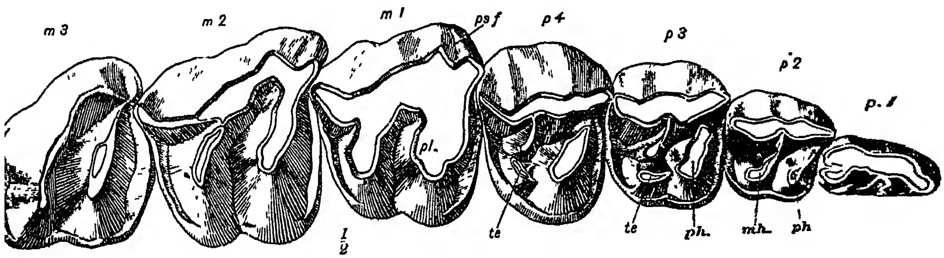

FIG. 36.—Molar teeth of *Aceratherium platycephalum*. × ½ *m* 1-*m*.3, Molars: *mh*, metaloph; *p* 1-*p* 4, premolars; *ph*, protoloph; *ps.f*, parastyle fossa; *te*, tetartocone. (After Osborn.)

may be regarded as having been developed between tubercles which they connect and whose distinctness as tubercles is thereby destroyed. Lophodont teeth are only found in vegetable-feeding animals.

The special characteristics of the teeth of various groups of animals will be considered further under the accounts of the several orders of recent and fossil Mammalia.

A very general feature of the teeth of the Mammalia is what is usually termed the diphyodont dentition. In the majority of cases there are two sets of teeth developed, of which the first lasts for a comparatively short time, and is termed on account of its usual time of appearance the "milk dentition"; this is replaced later by the permanent dentition. In lower vertebrates the teeth are replaced as worn away. There is not, however, so great an antithesis in this matter between the Mammalia

and other vertebrates as was at one time assumed. But in order to explain this very important part of the subject it will be necessary to give some account of the development of the teeth. The type selected is the Hedgehog, which has been recently and carefully described by Dr. Leche of Stockholm,

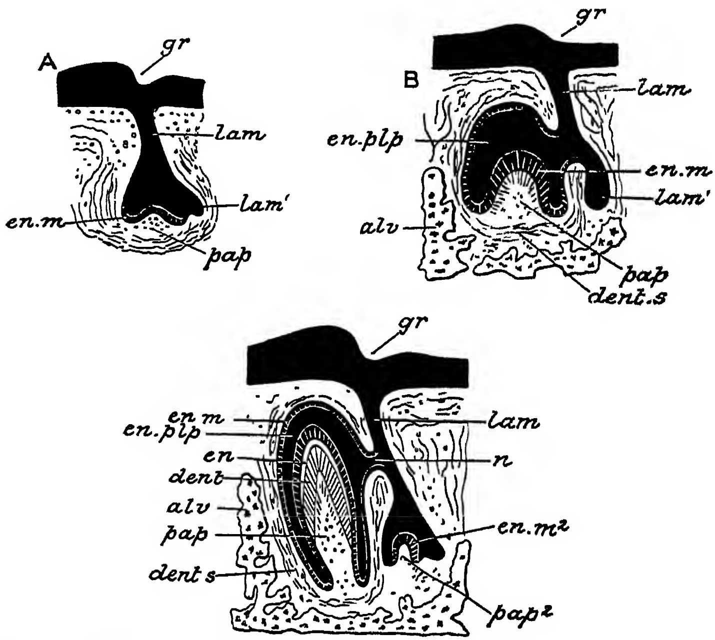

Fig 37 —Two stages in the development of the teeth of a Mammal (diagrammatic sections). *alv*, Bone of alveolus, *dent*, dentine, *dent.s*, dental sac; *en*, enamel; *en.m*, enamel membrane; *en.m*2, enamel membrane of permanent tooth; *en.plp*, enamel pulp; *gr*, dental groove; *lam*, dental lamina; *lam'*, part of dental lamina which grows downwards below the tooth germ, *n*, neck connecting germs of milk and permanent tooth, *pap*, dental papilla; *pap*2, dental papilla of permanent tooth. (After O. Hertwig.)

which type has furthermore the advantage of being a "central" type of mammal. The first step in the formation of the teeth is a continuous invagination of the epithelium covering the jaw to form a deepish wall of tissue running in the thickness of the jaw, this is perfectly continuous from end to end of the lower jaw. From this "common enamel germ" (*Schmelzleiste* of the Germans[1]) "special enamel germs" (*Schmelzorgane*, enamel organs) are developed here and there as thickenings in the form of buds

[1] *Morph. Jahrb.* xix. 1892, p. 502.

which arise on the outer side of the fold of epithelium and some way above its lower termination. These ultimately acquire a bell-like form, and are as it were moulded on to a thickened concentration of the dermis beneath; they then become separate from the downgrowth of the epithelium whence they have arisen. Finally, each of the eight germs becomes one of the milk teeth of the animal The lower end of the sheet of invaginated epithelium, the common enamel germ, is the seat of the formation of the second set of teeth, of which, however, in the animal under consideration, there are only two in each jaw. But corresponding to each of the enamel germs of the milk dentition, with the exception of the first two molars, there is a slight thickening of the end of the common enamel germ, which at a certain stage is indistinguishable from the thickening which will become one of the permanent teeth. We have thus the diphyodont arrangement. But this does not exhaust the series of rudimentary teeth, though no more come to maturity than those whose development has already been touched upon. In the upper jaw a small outgrowth of the common enamel germ arises above and to the outer side of the enamel germ of the third milk incisor; this does not develop any further, but its resemblance to the commencing germ of a tooth seems to indicate that it is the remnant of a tooth series antecedent to the milk series. Furthermore, there are indications in the fourth premolar of a fourth series of teeth posterior in appearance to the permanent dentition. We arrive therefore at the important conclusion that although here as elsewhere there are only two sets of calcified teeth ever developed, there are feeble though unmistakable remains of two other series, one antecedent to and the other posterior to the diphyodont dentition. The gap therefore which separates the mammalian dentition from that of reptiles is less than has hitherto appeared. Dr. Leche also carefully studied the tooth development of *Iguana;* he found that in this lizard there are four series of teeth which come to maturity, and a rudimentary series antecedent to these which never produces fully formed teeth.

In a few mammals there is a kind of dentition known as the monophyodont, in which only one series of teeth reaches maturity; where in fact there is no replacement of a milk series by a permanent dentition. Of the monophyodont dentition Whales form an example. The Marsupials are very nearly an instance of the

same phenomenon; for Sir W. Flower showed, and Mr. Thomas confirmed his discovery, that only one tooth, according to Mr. Thomas the fourth premolar, is replaced in that group. But even the purely monophyodont dentition of the Toothed Whales is a more apparent than real contrast to the diphyodont dentition elsewhere prevalent. An investigation of the embryos of various Toothed Whales by Dr. Kukenthal and by Dr. Leche has brought to light the highly important fact that two dentitions are present, but that one only comes to maturity; from this fact obviously follows the interesting question:—To which of the two dentitions of more normal Mammalia does the monophyodont dentition of the Whales and Marsupials belong? To this question a clear answer is fortunately possible. As has been pointed out in the foregoing sketch of tooth development, and has been illustrated in the figures, the milk teeth develop as lateral outgrowths of the common enamel germ, while the permanent teeth arise from the end of the same band of tissue. This fact enables it to be stated apparently beyond a doubt that in the Whales and in the Marsupials it is the milk dentition which is the only one to arrive at maturity. Thus the earlier theoretical conclusion that the Marsupial dentition "is a secondary dentition with only one tooth of the primary set left," is proved on embryological grounds to be untrue. But there are other monophyodont animals than those already mentioned.[1] *Orycteropus*, the Cape Anteater, is an example. Mr. Thomas has lately discovered that in this Edentate there is a set of minute though calcified milk teeth which probably never cut the gum; here we have a different sort of monophyodontism, in which the teeth belong to the second and not to the first set. Between the latter condition and the diphyodont state are intermediate stages. Thus in the Sea Lions the milk teeth are developed but disappear early, probably before the animal is born.

In the typical diphyodont dentition, such as is exhibited for example in Man and the vast majority of mammals, the milk teeth eventually completely disappear and are entirely replaced by the permanent set of teeth, with the exception, of course, of the molars, which though they are developed late belong to the milk series.

[1] It would be of the greatest interest in relation to this and many other problems to ascertain the precise meaning of the monophyodont dentition of *Ornithorhynchus*.

Their correspondence with the milk series is shown in an interesting way by the close resemblance which the last milk premolar often bears to the first molar. These two extremes of dentition, *i.e.* purely monophyodont and, excepting for the molars, purely diphyodont, are however connected by an intermediate state of affairs, which is represented by more than one stage. In *Borhyaena* (probably a Sparassodont) the incisors and the canines and two out of the four premolars belong to the permanent dentition, while the two remaining premolars and of course the three molars are of the milk series. *Prothylacinus*, a genus belonging to the same group, has a dentition which is a step or two further advanced in the direction of the recent Marsupials. We find, according to Ameghino,[1] whose conclusions are accepted by Mr. Lydekker, that the incisors, canines, and two premolars belong to the milk series, while the permanent series is represented only by the two remaining premolars. We can tabulate this series as follows:—

(1) Purely monophyodont, with teeth only of the first set—Toothed Whales.

(2) Incompletely monophyodont, as in the Marsupials, where there is a milk dentition with only one tooth replaced.[2]

(3) Incompletely diphyodont, with the dentition made up partly of milk, partly of permanent teeth, as in *Borhyaena*.

(4) Diphyodont, where all the teeth except the molars are of the second set; this characterises nearly all the mammals.

As we pass from older forms to their more recent representatives there is as a rule a progressive development of the form of the teeth. This is especially marked among the Ungulata. The extremely complicated type of tooth found in such a form as the existing Horse can be traced back through a series of stages to a tooth in which the crown is marked by a few separated tubercles or cusps. Arrived at this point, the differences between the teeth of ancestral Horses and ancestral Rhinoceroses and Tapirs are hard to distinguish with accuracy; and the same difficulty is experienced in attempting to give a definition of other large orders by the characters of the teeth, such as will apply to the Eocene or

[1] *Proc. Zool. Soc.* 1899, p. 922.

[2] Mr. M. Woodward, however (*P.Z.S.* 1893, p. 467), is disposed to think that in some Macropodidae at any rate the supposed tooth of the second set really belongs to the milk dentition, arising late between Pm_3 and Pm_4.

even earlier representatives of these families. Fig. 36 (p. 51) illustrating a series of mammalian teeth will illustrate the above remarks. That there is such a convergence in tooth structure shows that it is, theoretically at least, possible to determine the ancestral form of the mammalian tooth. Practically, however, the difficulties which beset such theorising are great; that there are such divergent and such strongly-held antithetical views is sufficient proof of this. Two main views hold the field: one, which has found most favour in America, and is due chiefly to the labours and persuasiveness of Professors Cope, Scott, Osborn, and others, is known as "trituberculy."[1] The alternative view, as urged by Forsyth Major, Woodward, and Goodrich, attempts to show that the dentition of the original mammal included grinding teeth which were multicuspidate or "multitubercular." There is much to be said for both views, and something to be said against both.

FIG. 38.—Molar teeth of A, *Phenacodus*, and B, the Creodont *Palaeonictis*. *End*, endoconid; *hld*, hypoconulid; *hyd*, hypoconid; *med*, metaconid; *prd*, protoconid. (After Osborn and Wortman.)

This question is, however, wrapped up in a wider one. Its solution depends upon the ancestry of mammals. If the Mammalia are to be derived from reptiles with simple conical teeth, then the first stage in the development of trituberculy is proved. On the other hand, however, the evidence is gradually growing that the Theromorpha represent more nearly than any non-mammalian group with which we are acquainted the probable ancestral form of the mammals. These animals offer some support to both the leading views. *Cynognathus* had triconodont teeth which, as will be pointed out later, are a theoretically intermediate stage in the evolution of tritubercular teeth; on the other hand, the teeth of *Diademodon* and some others are multituberculate, and have been very properly compared to the multitubercular teeth of such primitive mammalia as the Ornithorhynchus. Professor Osborn is no doubt correct in italicising a remark of an anonymous writer in *Science* to the effect that in *Diademodon* the teeth, though multitubercular, show the prevalence of three cusps arranged in the tritubercular fashion.

[1] See for a summary, Osborn, *American Nat.* Dec. 1897, p. 993.

But this may be only a proof that the multitubercular antedates the tritubercular. It may be, indeed, that the mammalian tooth was already differentiated among the mammal-like Saurians, and that from such a form as *Cynognathus* the Eutheria and other forms in which a tritubercular arrangement can be detected were evolved, and from such form as *Tritylodon* the Monotrematous branch of the mammals. This way of looking at the matter harmonises a much-disputed question, but involves a diphyletic origin of the mammals—an origin which for other reasons is not without its supporters.

We shall now attempt to give a general idea of the facts and arguments which support or tend to support "trituberculy." As a matter of fact the name is inaccurate, for the holders of this view do not derive the mammalian molar from a trituberculate condition, but in the first place from a simple cone such as that of a crocodile!

To this main and at first only cusp came as a reinforcement an additional cusp at each side, or rather at each end, having regard to their position with reference to the long axis of the jaw. This stage is the "triconodont" stage, and teeth exist among living as well as extinct mammals which show this early form of tooth. We have, indeed, the genus *Triconodon*, so named on that very account. Among living mammals the Seals and the Thylacine all show some triconodont teeth. A Toothed Whale, it may be remarked, is a living example of a mammal with monoconodont teeth. The three primary cusps, as the supporters of Cope's theory of trituberculism denominate them, are termed respectively the protocone, paracone, and metacone, or, if they are in the teeth of the lower jaw, protoconid, paraconid, and metaconid. At a slightly later stage, or coincidently, a rim partly surrounded the crown of the tooth; the rim is known as the cingulum, and from a prominent elevation of this rim a fourth cusp, the hypocone, was developed. The three main cones then moved, or rather two of them moved, so as to form a triangle; this is the tritubercular stage. Teeth of this pattern are common, and occur in such ancient forms as Insectivora and Lemurs, besides numerous extinct groups. An amendment has been suggested, and that is to term the teeth with the simple primitive triangle "trigonodont," and to reserve the term tritubercular for those teeth in which the hypocone has appeared. The platform bearing the hypocone widened into the

"talon"; and this ledge became produced into two additional cusps, the hypoconule or hypoconulid, and the ectocone or ectoconid. Thus the typical sextuberculate tooth of the primitive Ungulate, and indeed of many primitive Eutherians, is arrived at.

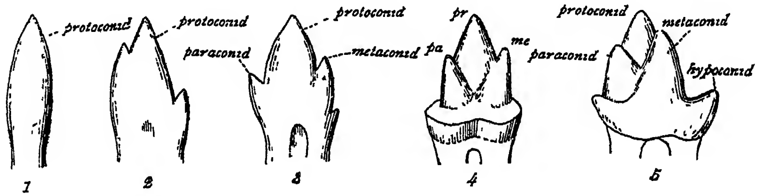

FIG. 39.—Epitome of the evolution of a cusped tooth. 1, Reptile; 2, *Dromatherium*; 3, *Microconodon*, 4, *Spalacotherium* *me*, metaconid; *pa*, paraconid; *pr*, protoconid; 5, *Amphitherium*. (After Osborn.)

From this the still further complicated teeth of modern Ungulates can be derived by further additions or fusions, etc.[1] On the other hand, the development of the Primate molar stops short at the stage of four cusps.

That such a series can be traced is an undoubted fact. Every stage exists, or has existed. But whether the stages can be connected or not is quite another question. It is by three main lines of argument that the view here sketched out in brief is supported. In the first place, the tracing of the pedigrees of many groups of mammals has met with very considerable success; and it is clear that as we pass from the living Horse and Rhinoceros, with their complicated molars, to their forerunners, we find that both can be referred to a primitive Ungulate molar with but six cusps. Going still further back to the lowest Eocene and ancestral type as it appears, *Euprotogonia*, we still find in the molar tooth the sextubercular plan of structure. We can hardly get further back in the evolution of the Perissodactyles with any probability of security. On the other hand, many facts point to a fundamental relationship between the primitive Ungulates and the early Creodonts. The latter frequently show plainly trituberculur molars. Such Ungulates as *Euprotogonia* and *Protogonodon*, though sex- or quinque-tubercular as to their molars, have a distinctly prevailing trituberculism, when the *size* and importance of three of the cusps is taken into account. But this

[1] *e.g.* the "protoloph," "metaloph," etc. (see Fig. 36, p. 51), of the modern Ungulate form of tooth.

lacks finality as a convincing proof of the tritubercular tooth as a primitive Ungulate tooth.

Professor Osborn has ingeniously utilised certain deviations from the normal type of tooth structure (for the group) in favour of his strongly-urged opinions. If the stages of development have been as he suggests, a retrogression would naturally be in the inverse order; thus the "apparently 'triconodont' lower molar of *Thylacinus*" may be interpreted as a retrogression from a tritubercular tooth. In the same way may be explained the triconodont teeth of Seals and of the Cetacean *Zeuglodon*. Finally, the modern Toothed Whales have retrograded into "haplodonty."

Embryological evidence has also been called in, and with some success, to contribute towards the proof of the tritubercular theory of teeth Taeker has shown that in the Horse and the Pig, and some other Ungulates, there is first of all a single hillock or cusp, and that later the additional cones arise separately. An apparent stumbling-block raised by these investigations is that it is not always the protocone or its equivalent in the upper jaw which arises first, as it obviously ought to do phylogenetically. This, however, is not a final argument in either direction. We know from plenty of examples that ontogenetic processes sometimes do not correspond in their order with phylogenetic changes. Thus in the mammalian heart the ventricle divides before the auricle; and of course, phylogenetically, the reverse ought to occur, since a divided auricle precedes a divided ventricle. This method of development has, moreover, been interpreted otherwise. It has been held to signify that the complex teeth of mammals are indeed derived from simple cones but by the fusion of a number of those cones.

On the other hand there are the claims of the multitubercular theory of the origin of mammalian teeth to be considered. The palaeontological evidence has been already, to some extent, utilised. The occurrence of such teeth among the possible forerunners of mammals, and in some of the most primitive types of Mammalia, has been referred to. Señor Ameghino dwells upon the sextubercular condition of many primitive mammals even belonging to the Eutheria. In a recent communication[1] he attempts to identify six tubercles in the molars of types belonging to a

[1] "On the Primitive Type of the Plexodont Molars of Mammals," *Proc. Zool. Soc.* 1899, p. 555.

variety of Orders. The same condition, as has been noted; characterises that ancient Ungulate form *Euprotogonia*. Even where the teeth seem at first sight to be trituberculár a detailed study shows traces of otherwise vanished cusps.

It must be remembered in basing arguments upon the early Jurassic and Cretaceous mammals, that our knowledge of them mainly depends upon lower jaws, the teeth of which are usually simpler in pattern than those of the upper jaws. Moreover, another fact, not always insisted upon, must not be lost sight of. In many of those creatures the jaws were of small size, and yet accommodated a large series of molar teeth. *Amphitherium*, for example, had six molar teeth, and five is a number frequently met with. As the teeth are so numerous and the jaws so small it seems reasonable to connect the simplicity of the structure of the teeth with the need for crowding a number together. The same argument may partly account for the superabundant teeth of many Toothed Whales. It is true that the Manatee has very numerous grinders which are yet complex; but then in this animal there is a succession, and the jaw does not hold at a given time the entire series, with which it is provided in relays. On the other hand, where there are few molars they are often of the multitubercular type, or at least approach it; of this the Multituberculate *Polymastodon* is a good example; so, too, the molars of *Hydrochoerus*, and of many other Rodents.

It is well known that the fourth deciduous molar of the upper jaw, which is replaced by a permanent premolar in the fully adult animal, is of a more complex structure than its successor. This may indeed be extended to premolars earlier in the series. In the Dog "the second and first milk molars closely resemble the third and second premolars"; now the milk premolars belong evidently to the same dentition as the permanent molars, and they are earlier teeth than the later-developed replacing teeth. It is therefore significant that these earlier teeth should be more cuspidate than the later teeth. It tells distinctly in favour of the simplification as opposed to the complication of teeth in time, in the groups concerned.

These facts may possibly be applied in explanation of the simple teeth of some of the Jurassic and Cretaceous mammals. It has been mentioned that absolute trituberculy is exceedingly rare among those ancient creatures, more generally there are to

be found at least traces of more cusps. Now in some of them we may be dealing with instances of a complete tooth change; the suppression, save for one tooth, which is found in Marsupials, was probably not developed in at least some of these early mammals. The simplicity may therefore have been preceded by complexity, and may have been merely an adaptation to an insectivorous diet.

Alimentary Canal.—The *mouth* of the Mammalia is remarkable for the fact that with a few exceptions, such as the Whales, there are thick and fleshy lips. The office of these is to seize the food. The roof of the mouth is formed by the "hard palate" in front, which covers over the maxillary and palatine regions. This region is often covered with raised ridges, which have a symmetrical disposition, and are particularly strong in Ruminant animals. They are much reduced in the Rodents, where the anterior part of the palate is ill-defined owing to the way in which its sides fade into the lateral surface of the face. It has been shown that these ridges, in the Cat at least, develop as separate papilliform outgrowths, and it has been suggested that these papillae, which later become united to form the ridges, are the last remnant of palatine teeth such as occur in lower vertebrates.

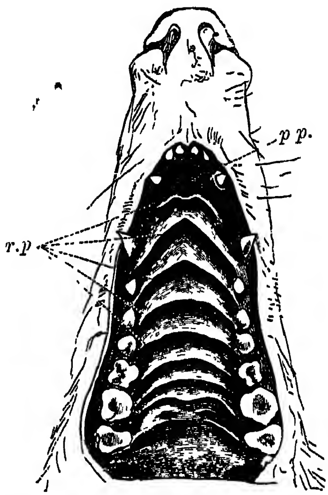

FIG. 40—Palatal folds of the Raccoon (*Procyon lotor*). *p.p*, Papilla palatina; *r.p*, palatal folds. (From Wiedersheim's *Structure of Man*.)

The *tongue* is a well-developed organ, usually playing a double part. It acts as an organ of prehension, especially in such animals as the Giraffe and the Anteater, where it is long and protrusible beyond the mouth for a considerable distance. It also carries gustatory organs, which serve for the discrimination of the nature of the food. Beneath the tongue there may be a hardish plate, known as the sublingua. This is especially prominent in the Lemurs, where it projects as a horny structure below the tongue, and has an independent and free tip. It is supported in some of these animals by a cartilaginous

structure. It is held by Gegenbaur that this organ is the equivalent of the reptilian tongue, and that in the skeletal vestiges which it contains are to be found the equivalents of the hyoid skeletal cartilages which support the tongue in lizards. In this case the tongue of mammals is a subsequently added structure.

The *oesophagus* leads from the mouth cavity to the *stomach*. The latter organ has commonly a distinctive shape in mammals. This is well shown in Man. The orifices of the oesophagus and intestine are somewhat approximated; and this causes a bulging of the lower border of the organ, usually spoken of as the greater curvature. A stomach of this typical form is found in many orders of mammals, and is unlike the stomach in any of the groups of lower vertebrates in shape. Sometimes the shape of the organ is greatly altered: it may be drawn out, sacculated, or divided, as in the Ruminants and Whales, into a series of differentiated chambers, each of which plays some special part in the phenomena of digestion.

The *intestine* of mammals is always long and much coiled, though the length and consequent degree of coiling naturally varies. On the whole it is perhaps safe to say that it is shorter in carnivorous than in vegetable-feeding beasts. Thus the Paca has an intestine of 39 inches total length, while the Cat, an animal of about the same size, has an intestine which is only 36 inches long. A fish diet, however, to judge from the Seals, is associated with a long intestinal tract. The intestine is divisible in the vast majority of mammals into a small and a large intestine. The two are separated by a valvular constriction save in certain Carnivores; and in the majority of cases the distinction is also emphasised by the presence at the junction of a blindly-ending diverticulum, the *caecum*. This latter organ varies greatly in length, being very short in the Cat-tribe and exceedingly long in Rodents. Its size is, to some extent, dependent upon the flesh-eating or grass-eating propensities of the animal in which it occurs. One of the longest caeca is possessed by the Vulpine Phalanger, in which the organ is one-fifth of the length of the small intestine; while the opposite extremity is reached by *Felis macroscelis*, which has a small intestine one hundred times the length of the caecum.

An interesting point in connexion with the gut of mammals

is the varying proportion of the small to the large intestine. As a general rule the former is very considerably longer than

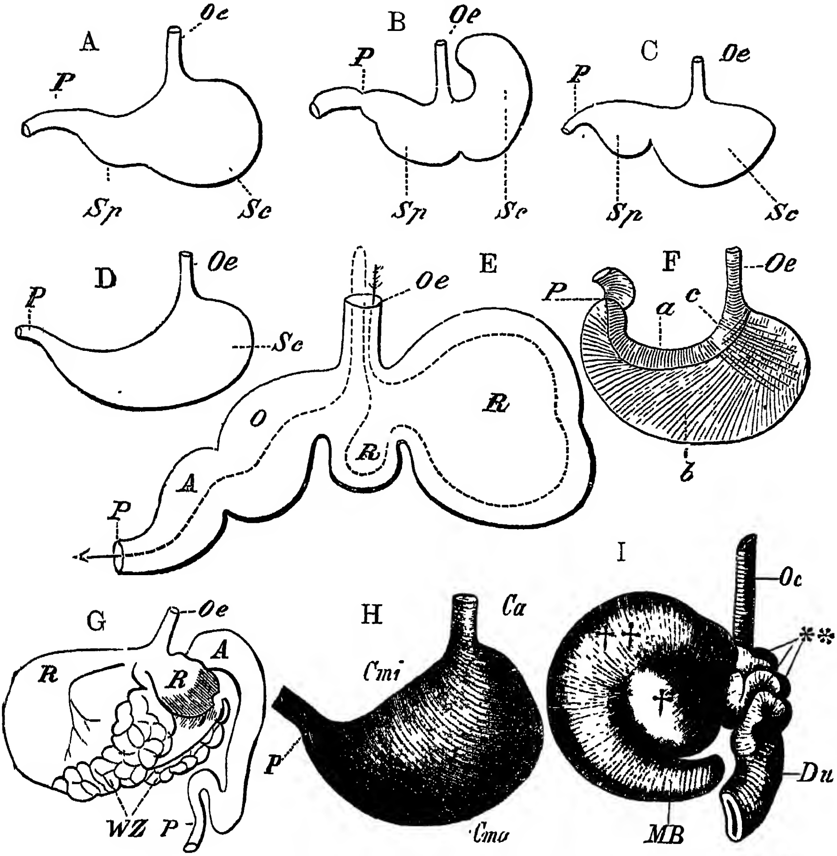

FIG. 41.—Different forms of the stomach in Mammals. A, Dog; B, *Mus decumanus*; C, *Mus musculus*, D, Weasel; E, scheme of the Ruminant stomach, the arrow with the dotted line showing the course taken by the food, F, Human stomach. *a*, Minor curvature; *b*, major curvature; *c*, cardiac end. G, Camel; H, *Echidna aculeata* *Cma*, Major curvature; *Cmi*, minor curvature. I, *Bradypus tridactylus*. *Du*, Duodenum; *MB*, coecal diverticulum; **, outgrowths of duodenum; †, reticulum; ††, rumen. *A* (in E and G), Abomasum; *Ca*, cardiac division; *O*, psalterium; *Oe*, oesophagus; *P*, pylorus; *R* (to the right in E and to the left in G), rumen; *R* (to the left in E and to the right in G), reticulum; *Sc*, cardiac division; *Sp*, pyloric division; *WZ*, water-cells. (From Wiedersheim's *Comparative Anatomy*.)

the latter; in *Paradoxurus*, for instance, the small intestine may be fifteen times the length of the large. The excess of length of one section over the other is not generally so marked

as this. In *Phalanger maculatus* the two sections of the gut are as nearly as possible equal in length, while in *Phascolarctos* the large intestine is considerably longer than the small, the lengths being respectively 160 inches and 111 inches. It is common among the Marsupials and also among the Rodents for these proportions to exist, *i.e.* for the large intestine to be as long as, or longer than, the small. But there are so many exceptions that no general statements can be extracted from the facts.

Some few details will be found in the systematic part of this book. Mr. Chalmers Mitchell has brought forward some reasons for associating a great length of large intestine with an archaic systematic position, in the birds at any rate. The facts here briefly touched upon are not at variance with the extension of such a view to the mammals.

Appended to the alimentary tract are three glands or sets of glands. Opening into the mouth cavity are the *salivary glands*, which are of enormous size in Anteaters, and small or absent in Whales. In their number and position these glands are characteristic of mammals. Into the intestine open the ducts of the pancreas and liver, two glands which the mammals share with lower vertebrates. The form of the *liver* is, however, generally characteristic of mammals. It is divided as a rule into a right and a left half, the line of division

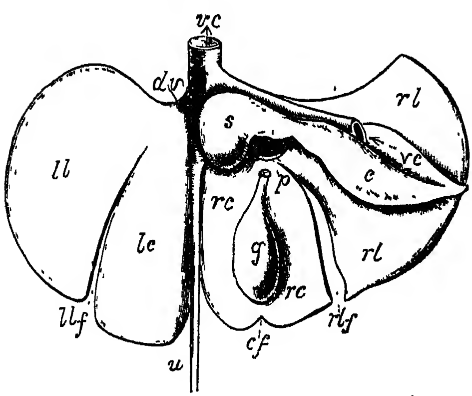

FIG. 42.—Diagrammatic plan of the liver of a Mammal (posterior surface) *c*, Caudate lobe; *cf*, cystic fissure, *dv*, ductus venosus; *g*, gall-bladder; *lc*, left central lobe, *ll*, left lateral lobe, *llf*, left lateral fissure, *p*, portal vein entering transverse fissure; *rc*, right central lobe, *rl*, right lateral lobe; *rlf*, right lateral fissure, *s*, Spigelian lobe; *u*, umbilical vein; *vc*, post-caval vein. (After Flower and Lydekker.)

being marked by the insertion of the umbilical ligament, a vestige of the primitive ventral mesentery. Each half is again commonly subdivided into central and lateral lobes. In addition to these, two other divisions are often to be seen—the Spigelian and the caudate lobe. The liver is less divided in Cetacea and

some others, very much subdivided in Rodents and other groups. The degree of subdivision and the proportions of the several lobes frequently offer valuable systematic characters. The gall-bladder may be present or absent; it is always a diverticulum of the hepatic duct. The two are never separate, as in birds, for instance.

Organs of Circulation.—The heart of all mammals is a completely four-chambered organ. In the adult heart there is no communication between the right and left halves. The auricles are comparatively thin-walled, the ventricles thick-walled, in relation to the amount of work that they have severally to perform. The right ventricle, moreover, which has only to drive the blood into the lungs, is much thinner-walled than the left ventricle, which is concerned with the entire systemic circulation. The exits of the arteries and the auriculo-ventricular orifices are guarded by valves, which are so arranged as only to permit the blood to flow in the proper direction. But these valves have a morphological as well as a physiological interest. At the origin of each artery, the aorta and the pulmonary, there is a row of three watch-pocket valves, as they have been generally termed on account of their form. These three valves meet accurately in the middle of the lumen of the arterial tube when liquid is poured into them from above, and thus completely occlude the orifice. The auriculo-ventricular valves differ in structure in the two ventricles. That of the left ventricle has only two flaps, and is therefore often spoken of as the bicuspid or mitral valve. Both these flaps are membranous, and together they completely surround the exit from the auricle into the ventricle. The edges of the valve are bound down to the parietes of the heart by numerous branching tendinous threads, the chordae tendineae, which often take their origin from pillar-like muscles arising from the walls of the heart, the so-called musculi papillares. The valve of the right ventricle is composed of three flaps, and is therefore often spoken of as the tricuspid valve; it is in the same way membranous, and has chordae tendineae and musculi papillares connected with it. The disposition of the musculi papillares and their number differ in different mammals, but no exhaustive study has as yet been made of the arrangements in different groups; the amount of individual variation even is not known, though it is certainly considerable in some cases, for in-

stance in the heart of the Rabbit. The heart of the Monotremata presents differences of some importance from those of other Mammalia; the modern knowledge of the Monotrematous heart is mainly due to Gegenbaur[1] and Lankester,[2] in whose memoirs references to the older literature will be found. The principal features of interest in which the heart of the Monotremata differs from that of the higher Mammalia are these. When the two ventricles are cut across transversely, the cavity of the right is seen to be wrapped round that of the left in a fashion precisely like that of the bird's heart; on the other hand in the higher mammal the two cavities lie side by side. The main difference between Monotremes and other Mammals concerns the right auriculo-ventricular valve. The differences which it presents from the corresponding structure of the rest of the Mammalia are two: in the first place, the valve itself does not completely surround the ostium; it is only developed on one side; the septal half (*i.e.* that turned towards the interventricular septum) is either entirely absent or more generally represented by a small bit of membrane, nevertheless I found[3] recently in an *Ornithorhynchus* heart a complete septal half to the right auriculo-ventricular valve. The second point of interest in connexion with this valve is, that the musculi papillares instead of ending in chordae tendineae attached to the free edge of the valve are directly attached to the valve, and in some cases pass through its membranous flap, to be attached to its origin at the boundary of the auricle and of the ventricle. The invading of the valve-flap by muscle in this way is highly interesting, as it recalls the heart of the bird and of the crocodile. The imperfect condition of the valve (from which, as has already been stated, the septal half is as a rule nearly absent) is a point of resemblance to the heart of the bird; the corresponding valve of the crocodile's heart being complete.

There are also features in the system of arteries and veins which are eminently distinctive of mammals. In the first place, the aorta leaving the heart and conveying blood to the body is only a half arch, and bends to the left side as seen in Fig. 43. The right and left halves are present in reptiles, and meet behind the heart. In the bird the right half alone

[1] *Jen. Zeitschr.* ii. 1866, p. 365.
[2] *Proc. Zool. Soc.* 1883, p. 8.
[3] *Proc. Zool. Soc.* 1894, p. 715.

has remained. This fact, therefore, shows that the mammal cannot have been derived from a bird-like ancestor, but that

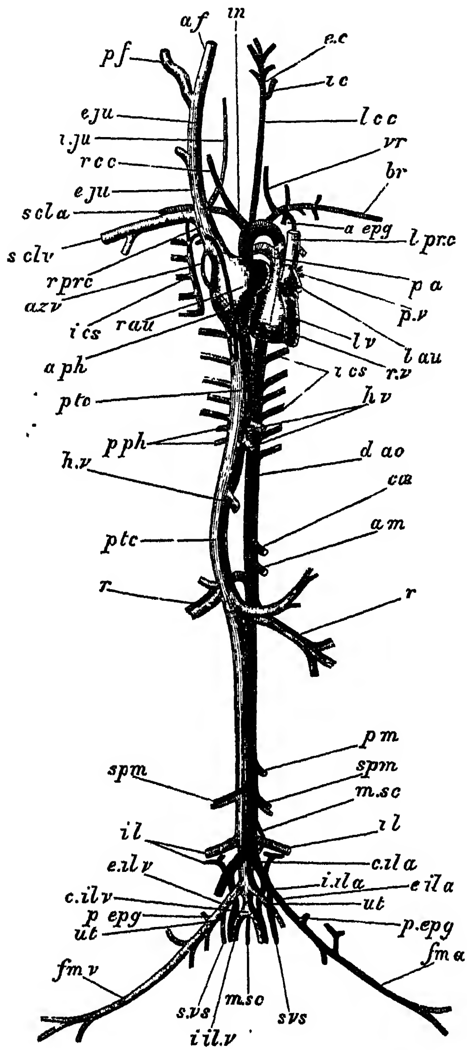

FIG. 43.—*Lepus cuniculus*. Ventral view of the vascular system. The heart is somewhat displaced towards the left of the subject; the arteries of the right and the veins of the left side are in great measure removed. *a epg*, internal mammary artery, *a.f*, anterior facial vein; *a.m*, anterior mesenteric artery, *a.ph*, anterior phrenic vein, *az.v*, azygos vein, *br*, brachial artery; *c il.a*, common iliac artery, *c il.v*, common iliac vein; *cœ*, coeliac artery; *d ao*, dorsal aorta: *e c*, external carotid artery, *e.il.a*, external iliac artery; *e.il.v*, external iliac vein; *e ju*, external jugular vein; *fm.a*, femoral artery; *fm v*, femoral vein; *h v*, hepatic veins; *i c*, internal carotid artery; *i cs*, intercostal vessels, *i.il.a*, internal iliac artery; *i il.v*, internal iliac vein, *i ju*, internal jugular vein; *i.l*, iliolumbar artery and vein; *in*, innominate artery, *l.au*, left auricle; *l.c.c*, left common carotid artery; *l.pr.c*, left pre-caval vein; *l.v*, left ventricle; *m.sc*, median sacral artery; *p.a*, pulmonary artery; *p.epg*, epigastric artery and vein; *p.f*, posterior facial vein; *p.m*, posterior mesenteric artery; *p.ph*, posterior phrenic veins; *pt.c*, post-caval vein; *p.v*, pulmonary vein, *r*, renal artery and vein; *r.au*, right auricle, *r.c.c*, right common carotid artery; *r.pr.c*, right pre-caval vein, *r.v*, right ventricle; *s.cl.a*, right subclavian artery; *s cl v*, subclavian vein; *spm*, spermatic artery; *s.vs*, vesical artery, *ut*, uterine artery and vein; *vr*, vertebral artery. (From Parker's *Zootomy*.)

both must have independently come from an ancestor with both halves of the aortic arch present, of which one half has disappeared in one group, and the other half in the other. It is an interesting fact, too, to notice that the four

cavities of the mammal's heart, which fourfold division it shares with birds alone, do not exactly correspond compartment for compartment with those of the bird's heart, at least in so far as concerns the ventricles. For the reptilian heart is provided with only one ventricle, and therefore the division of that cavity must have been independently accomplished in mammals and in birds.

There are two features in the venous system which distinguish all the Mammalia (with the exception of *Echidna* in one of these points) from vertebrates standing lower in the series. The hepatic portal system is limited to a vein which conveys to the liver blood derived from the alimentary tract; in no mammal except in *Echidna* is there any representative of the anterior abdominal vein of lower vertebrates. In that animal there is such a vein, which apparently arises from a capillary network upon the bladder and passes up, supported by a membrane, along the ventral wall of the abdomen to the liver, thus emptying blood into that organ exactly as does the anterior abdominal vein of the frog. In no mammal is there any trace of a renal portal system. The kidneys derive their blood from the renal arteries only.

Many mammals have two superior venae cavae; this is the case, for instance, in the Elephant and the Rodents and other types lying comparatively far down in the series. In most if not in all mammals there are considerable remains of one of the posterior cardinals, in the form of the azygos vein, which opens into the vena cava superior or pre-caval vein, *i.e.* the superior cardinal just before the latter debouches into the heart. This one posterior cardinal is usually on the right side; but it may be on the left side, for instance in *Trichosurus vulpecula*. In *Halmaturus bennettii* there are two azygos veins, one left and one right, of which the left is rather the larger.[1]

Urinary Organs.—The kidneys in the Mammalia have a compact form, which contrasts with the somewhat diffuse and vaguely-outlined kidneys of the Sauropsida. In mammals the organ is as a rule of that peculiar shape which is called "kidney-shaped"; a depression termed the hilum, which receives the ducts of the glands, indenting the border of an otherwise oval-shaped gland. In some few mammals the kidney is broken up

[1] Beddard, *Proc. Zool. Soc.* 1895, p. 136.

into lobules; this is the case with the Whales, the Bears, the Oxen, and a few other forms. A curious fact about the kidneys of the Mammalia is their very general asymmetry of position. One of them usually lies in a more advanced position than the other. The ureters lead from the kidneys to the urinary bladder, which in its form and relations is quite distinctive of the Mammalia. The bladder is formed out of the remains of the allantois, and is therefore not the exact homologue of the bladder of the frog, which is the equivalent of the entire sac which grows out of the cloaca in the mammal, and is the foetal allantois. The ureters open into the bladder in the higher Mammalia, but lower down in the urino-genital passage in the more primitive mammals.

The Body Cavity.—The Mammalia differ from all other living vertebrates by the arrangement of the body cavity in which lie the viscera. That cavity is divided into two by a partly muscular and partly tendinous partition, the diaphragm. No other vertebrate has this precise disposition of the coelom. The diaphragm lies usually transversely to the longitudinal axis of the body, but gets a much more oblique arrangement in the Cetacea and the Sirenia, whose needs demand a more expanded chamber for the lungs. For in front of the diaphragm lie the lungs and heart; behind it the stomach, liver, intestines, and the organs of reproduction and excretion. The diaphragm is used in respiration; when its muscles contract, the surface directed toward the pleural cavity becomes less convex, and the cavity of the lungs is thus increased, allowing them to expand under the pressure of the entering air.

The Lungs.—The lungs of the Mammalia differ from those of animals lying lower in the series by the fact, just referred to, that they occupy a pleural cavity completely shut off from the abdomen by the diaphragm. As a rule the lungs of the Mammalia are to be distinguished by their more or less extensive lobation. In the Whales, however, and in the Sirenia, they are not much divided, but present the appearance of the simple sac-like lungs of the reptiles. In some mammals there is a median and posterior unpaired lobe of the lung, which lies in the post-pericardial cavity behind the pericardium. This is not universally present. The lungs are very frequently not symmetrical in their lobation, the number of separate lobes on the right side

and on the left being different. The lungs of mammals agree with those of the lower reptiles in being freely suspended within their coelomic cavity, and in not being, as in birds, crocodiles, and the Varanidae among lizards, tied down to the dorsal surface of that cavity by a sheet of peritoneum covering them.

The Gonads (Ovaries and Testes).—The ovary in the Mammalia is always paired; there is never a partial or complete abortion of one gonad as in birds—except of course in pathological cases. The ovaries are small, and lie in the

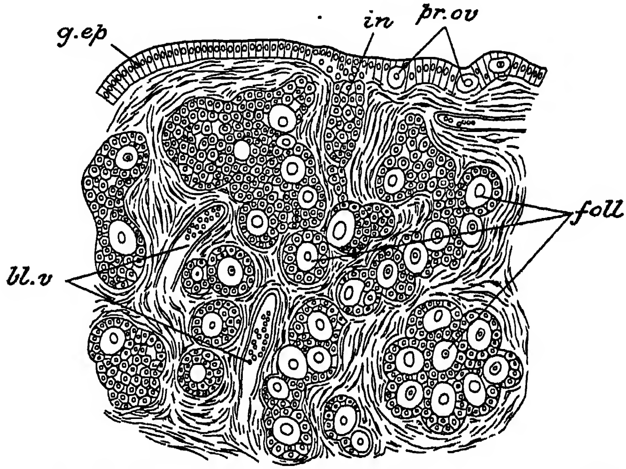

FIG. 44.—Part of a sagittal section of an ovary of a child just born. *bl.v*, Blood-vessels; *foll*, strings and groups of cells derived from the germinal epithelium, becoming developed into follicles; *g.ep*, germinal epithelium; *in*, ingrowing cord of cells from the germinal epithelium; *pr ov*, primitive ova. (From Hertwig, after Waldeyer)

abdominal cavity behind the kidneys. In the immense majority of the Mammalia the ova which are produced within the ovaries are of minute size; those of even the colossal Rorqual are, so far as we know, not markedly larger than the ova of a Mouse. The smallness of size of these reproductive elements implies necessarily an absence of much nutritive yolk; and as a consequence the developing embryo, since it is not hatched in an early stage as a free living larva, has to be nourished by the mother, to whose tissues it is attached through the intermediary of the placenta, a structure partly composed of foetal structures derived from the embryo, and partly of portions of the lining membranes of the uterus of the mother. The ova of the

Eutherian mammals, including the Marsupials, are very small as compared with those of any other vertebrates, excepting only *Amphioxus*, where the young are hatched early as free swimming larvae. They also differ in a highly characteristic way in the mode of their development within the ovary. These processes are to some extent illustrated in Fig. 44. The main framework of the ovary is formed of the so-called "stroma," which is a mass of tissue formed of more or less connective-tissue-like cells. Within this are numerous cavities, the Graafian follicles. The very young follicles consist of but a single layer of follicular cells surrounding the ovum, which lies centrally. The follicular

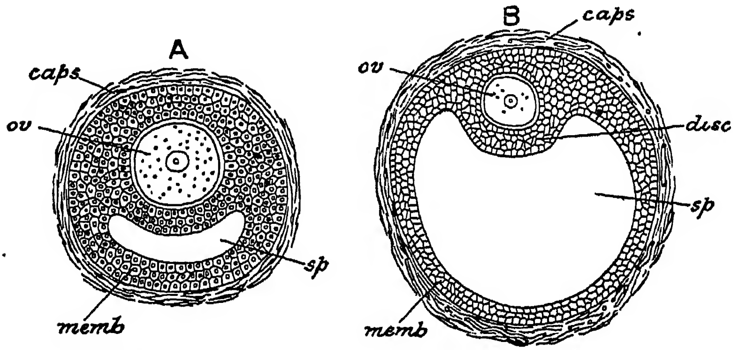

FIG 45.—Two stages in the development of the Graafian follicle. A, With the follicular fluid beginning to appear; B, after the space has largely increased. *caps*, Capsule; *disc*, cumulus proligerus; *memb*, membrana granulosa; *ov*, ovum; *sp*, space containing fluid. (After Hertwig)

cells gradually increase in number until the ovum lies in the midst of several layers of cells. At this period a vacuity is formed between some of these cells, and grows into a large cell-free cavity; the ovum does not lie loosely in this space, but is connected at one side with the follicular cells, which still line the interior of the Graafian follicle by the so-called discus or cumulus proligerus. The egg or ovum has, moreover, a layer of cells immediately surrounding itself. All these facts can be gathered by an inspection of Fig. 45. It has been shown that, as in lower vertebrates, the cells immediately surrounding the ovum are connected with it directly by delicate processes which penetrate the actual membrane of the egg.

The only ova which depart at all in structure from that above described are those of the Monotremata. The credit of this

discovery rests with Owen and with Professor Poulton, who pointed out in 1884,[1] that the ovum of *Ornithorhynchus* is very large as compared with those of other Mammalia (6 mm. as against ·2 mm.), that it is filled with yolk, and that it completely fills the follicle, being surrounded by two layers of follicular cells only. This latter fact was proved by Caldwell. Subsequently Gyldberg[2] and I[3] described the ovarian ovum of *Echidna*,

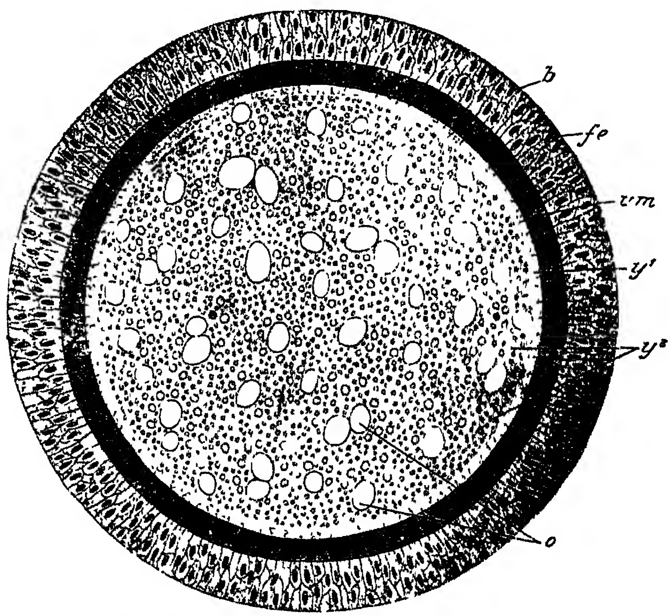

FIG 46.—Ovarian egg of *Echidna*. *b*, Basilar membrane; *fe*, follicular epithelium; *o*, oil globules; *vm*, vitelline membrane; y^1, y^2, yolk (Partly after Caldwell.)

showing it to be identical with that of *Ornithorhynchus*. Later still a more elaborate and beautifully illustrated paper was published by Caldwell[4] upon the early stages of development in the Monotremata and Marsupials, in which the ovum of the former was accurately described (see Fig. 46). In the particulars mentioned above, the ovum of the Monotremata is practically identical with that of the large-yolked ova of the Sauropsida.

1 *Quart. Journ. Micr. Sci.* xxiv. 1884, p. 9.
2 *S.B. Jen. Gesells.* 1885, p. 1.
3 *Proc Roy. Phys. Soc. Edin.* viii. 1885, p. 354.
4 *Phil. Trans.* clxxviii. 1887. p. 463.

It is the general rule among vertebrate animals that the ovaries are completely independent of the ducts which convey their products to the exterior. In certain fishes, however, there is an absolute continuity between the two structures, which is believed to be due to a simple concrescence between the originally distinct ovary and oviduct. The latter has grown round the former, an obvious advantage in preventing the eggs from wandering into the abdominal cavity and becoming lost. In the Mammalia we find discontinuity as a general rule. But in quite a number of forms folds of the lining membrane of the abdominal cavity are developed, which practically ensure the passage of the ova into the oviduct when they are extruded from the ovaries. The oviduct, moreover, has a large and fimbriated mouth, called in human anatomy—which is provided with a number of fanciful names—the morsus diaboli. This almost wraps round the ovary, and thus prevents the ova from straying in the wrong direction. Moreover, the ovary itself is often so arranged that it can easily be withdrawn into a pocket of the peritoneum, from which the obvious exit is by the gaping mouth of the oviduct. This disposition of the generative parts is still further modified in a few animals, such as the Rat[1] and the Kinkajou.[2] In these animals the mouth of the oviduct actually opens into the interior of a closed chamber which contains the ovary. In this case there is but one route for the

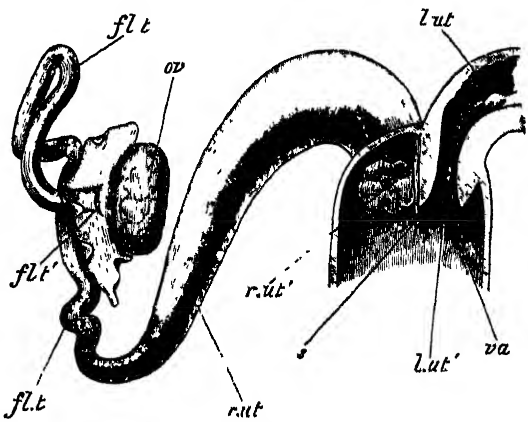

FIG. 47.—*Lepus cuniculus.* The anterior end of the vagina, with the right uterus, Fallopian tube, and ovary. (Nat. size.) Part of the ventral wall of the vagina is removed, and the proximal end of the left uterus is shown in longitudinal section. *fl.t*, Fallopian tube; *fl.t'*, its peritoneal aperture; *l.ut*, left uterus; *l.ut'*, left os uteri; *ov*, ovary; *r.ut*, right uterus; *r.ut'*, right os uteri; *s*, vaginal septum; *va*, vagina. (From Parker's *Zootomy*.)

[1] Robinson, *Studies Biol. Lab. Owens Coll.* ii. 1890, p. 35.
[2] Beddard, *Proc. Zool. Soc.* 1900, p. 667.

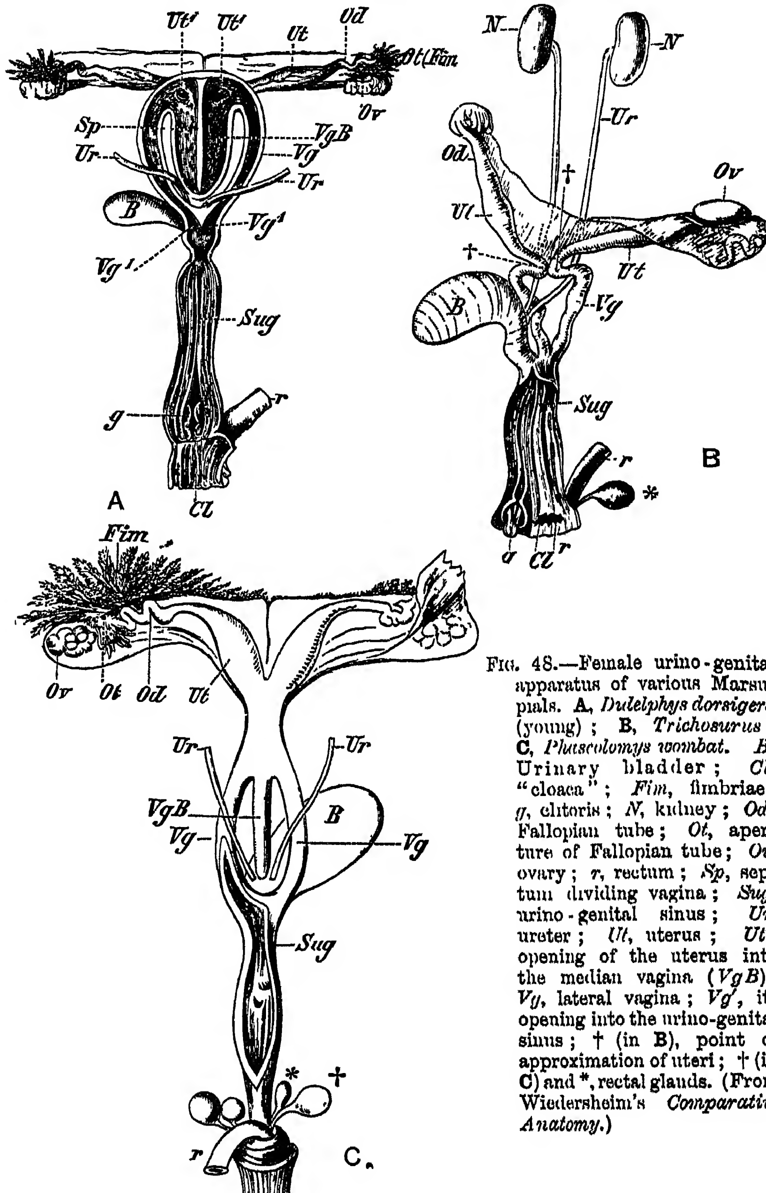

FIG. 48.—Female urino-genital apparatus of various Marsupials. **A**, *Didelphys dorsigera* (young); **B**, *Trichosurus*; **C**, *Phascolomys wombat*. *B*, Urinary bladder; *Cl*, "cloaca"; *Fim*, fimbriae; *g*, clitoris; *N*, kidney; *Od*, Fallopian tube; *Ot*, aperture of Fallopian tube; *Ov*, ovary; *r*, rectum; *Sp*, septum dividing vagina; *Sug*, urino-genital sinus; *Ur*, ureter; *Ut*, uterus; *Ut′*, opening of the uterus into the median vagina (*VgB*); *Vg*, lateral vagina; *Vg′*, its opening into the urino-genital sinus; † (in **B**), point of approximation of uteri; † (in **C**) and *, rectal glands. (From Wiedersheim's *Comparative Anatomy*.)

extruded ova to follow. This series of steps in the perfecting of the mode of safe extrusion of the ova is highly interesting,

and is a piece of evidence in favour of the high position of the mammals.

The oviducal apparatus of the mammal is more specialised than that of lower vertebrates. It is most simple, as might be imagined, in the egg-laying Monotremes, where, indeed, it is on the same level as that of reptiles. But in the Eutheria the fimbriated mouth of the oviduct passes into a narrow and winding tube, the Fallopian tube; this widens into a uterus, and the two uteri combine into a single tube in the higher forms. They are called the Monodelphia on this account. In the Marsupials the uteri are distinct though they often join above, and from this junction depends a median "uterus." After the uterus or the uteri follows in every case a single vagina.

The testes of the Mammalia, like those of other vertebrates, occupy primitively a position within the body cavity precisely corresponding to that of the ovaries. And in the lowly-organised Monotremata, and some other forms, such as the Whales, they retain that primitive position within the body. It is, however, distinctive of the Mammalia as opposed to lower vertebrates that the testes descend later into a scrotum, which is simply a protrusion of the skin of the body surrounded by muscles, and, of course, containing a section of the body cavity in which lie the testes. The penis of the Mammalia, represented by the clitoris and associated structures in the female, is of a structure entirely peculiar to this group.

The Brain.—Inasmuch as Professor Wiedersheim has said with perfect truth that "the brain of the extinct Ungulate *Dinoceras* shows so striking a likeness to that of a lizard that one would be compelled to explain it as that of a lizard without a knowledge of the skeleton," it is clear that to define the mammalian brain is a difficult matter. The existing Mammalia, however, all possess brains which can be readily distinguished from those of vertebrates lying lower in the scale. They are of relatively large size, brought about mainly by the dimensions of the cerebral hemispheres, which have an importance in this class of vertebrates that they have not elsewhere. Coupled with this large size of the hemispheres is a more elaborate system of transverse commissures uniting the two; and this culminates in the higher Mammalia, where the corpus callosum attains a large size and great physiological importance. A

very marked feature, moreover, of the mammal's brain is the development of regular fissures upon its surface, which fissures are only absent from *Ornithorhynchus*, various small Rodents,

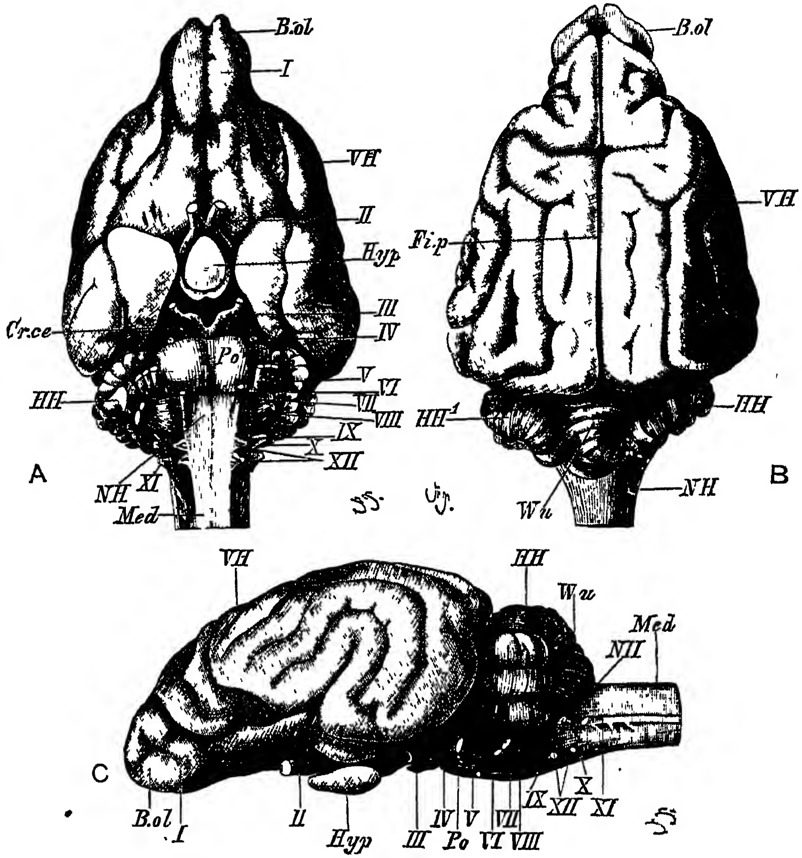

FIG. 49.—Brain of Dog. **A**, ventral; **B**, dorsal, **C**, lateral aspect. *B.ol*, Olfactory lobe; *Cr.ce*, crura cerebri; *Fi.p*, great longitudinal fissure; *HH*, *HH*¹, lateral lobes of cerebellum; *Hyp*, hypophysis; *Med*, spinal cord; *NH*, medulla oblongata; *Po*, pons Varolii, *VH*, cerebral hemispheres; *Wu*, middle lobe (vermis) of cerebellum; *I-XII*, cerebral nerves. (From Wiedersheim's *Comparative Anatomy*.)

Bats, and Insectivores, among living mammals. It is sometimes, but erroneously, said that the more complicated the fissures of the brain are, the higher in intelligence and "zoological position" is the possessor of that brain. Instances can undoubtedly be quoted to support such a view; but they are

merely selected cases, which do not indicate a wide applicability of such a generalisation. Thus it is true that the brain of a Man is more elaborate in its furrows and convolutions than is that of a Cat. The real fact of the matter is, that the complexity of the brain from this point of view increases with the size of the animal within the group.

The Gorilla and the Chimpanzee have a more furrowed brain than has the little Marmoset; the Bear a more complicated brain than the Weasel, etc. The most highly-convoluted brains of all mammals are those of the Elephants, and there does not

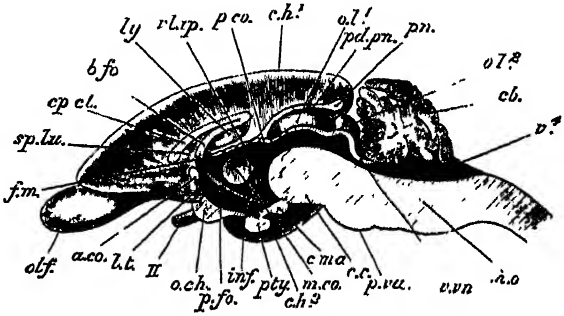

FIG. 50.—*Lepus cuniculus.* Longitudinal vertical section of the brain. (Nat. size.) *a.co*, Anterior commissure; *b.fo*, body of the fornix; *cb*, cerebellum, showing arbor vitae; *c.c*, crus cerebri; *c.h*¹, parencephalon or cerebral hemisphere; *c.h*², temporal lobe; *c.ma*, corpus mammillare; *cp.cl*, corpus callosum; *f.m*, foramen of Monro; *inf*, infundibulum; *l.t*, lamina terminalis; *ly*, lyra; *m.co*, middle commissure; *m.o*, medulla oblongata; *o.ch*, optic chiasma; *o.l*¹, *o.l*², corpora quadrigemina or optic lobes; *olf*, olfactory lobe; *p.co*, posterior commissure; *pd.pn*, peduncle of the pineal "gland," *pn*; *p.fo*, anterior pillar of the fornix; *pty*, pituitary body; *pv.a*, pons Varolii; *sp.lu*, septum lucidum; *v*⁴, fourth ventricle; *vl.ip*, velum interpositum; *v.vn*, valve of Vieussens; *II*, optic nerve. (From Parker's *Zootomy.*)

seem in the Ungulates to be so marked a relation between size and abundance of fissures as there is among other mammals. A regular plan of the fissures can be detected with certainty for each group considered by itself; but it is not so easy to homologise the details of arrangement from group to group. This is so far in accord with the view that the existing groups of mammals have diverged from each other *ab initio*.

Another marked characteristic of the mammalian as opposed to other brains is the relatively small importance in size and yet the fourfold nature of the optic lobes. What was the case with the optic lobes of the early Ungulates is difficult to understand, on account of the fact that the casts are necessarily imperfect.

Altogether the enormous progress in the complexity of the brain from the early Tertiary mammals down to the present, is one of the most remarkable revelations of palaeontology. It goes perhaps some way in explaining the remarkable diversity in mode of life exhibited by the mammals as compared, for example, with the birds, whose brains have not diverged so much or in so many directions from the primitive form.

The present Distribution of the Mammalia.—In the following pages some of the principal facts in the geographical range of the orders, families, and many of the genera of Mammalia will be given. It has been justly observed by Mr. Sclater that the habitat of an animal is as much a part of its definition as is its structure or external form. No systematic account of the Mammalia would therefore be complete without such geographical facts. But that branch of zoology which is concerned with the past and present distribution of animals is wider in scope than this. Zoogeography deals not only with the actual facts in the range of animals, but with the inferences as to past changes in the relations of land and sea which the facts seem to indicate, and with speculations as to the place of origin of the different groups, of which more than hints are sometimes given by their past and present distribution. In addition to this, the earth can be mapped out into provinces and regions which are definable by their animal inhabitants. In the present volume, dealing only with the Mammalia, it will be obviously impossible to enter fully into the entire subject of zoogeography. All that will be attempted is a brief general survey of the science so far as it can be illustrated by the Mammalia. For fuller knowledge the reader is referred to the treatises mentioned below.[1]

There are certain facts in the distribution of animals which are commonplaces of knowledge, but which may be set forth with definiteness. Everybody knows that an animal has a given range: Elephants, for example, are found in India and certain adjacent parts of Asia, and again in Africa; the Rhinoceroses have roughly the same range; the Tiger is limited to Asia; the

[1] Wallace, *The Geographical Distribution of Animals*, 1876. Heilprin, *The Distribution of Animals*, Internat. Scientific Series, 1887. Beddard, *A Text-book of Zoogeography*, Cambridge Natural Science Manuals, 1895. Lydekker, *Geographical History of Mammals*, Cambridge Geographical Series, 1896. W. L. and P. L. Sclater, *The Geography of Mammals*, Kegan Paul and Co. 1899.

Jaguar to America, and so forth. The entire expanse of country which is inhabited by an animal is called its area of distribution. Such areas are larger or smaller. The Lion ranges over the whole of Africa, a small part of India, and some neighbouring countries; on the other hand, the Insectivore *Solenodon* is limited to Cuba and Hayti, a separate species to each. Among other groups of animals are instances of an even more restricted range. There are humming-birds confined to the slopes of a single mountain, and fishes limited in their range to a single small lake.

A species may be found everywhere within the area of its distribution, or it may be confined to a number of limited tracts within that area. In this case it is usual to speak of "stations." In such cases the species in question is generally suited to some particular kind of environment. Thus the Otter and other aquatic mammals will only be found where there is water; and intervening tracts of waterless country will contain no Otters. Goats and Chamois live only upon mountains; the intervening plains are destitute of them. This discontinuity of distribution within the area is very general. But a discontinuity of area is also seen—not so commonly however; and, indeed, when it does occur, it is a matter of a genus and not of a species. Thus the Tapir is found in the East Indies on the one hand and in South and Central America on the other, being absent in the intermediate tracts.

It is clear that tracts of country eminently suitable for the housing of a particular mammal do not always possess that kind, or even an allied form. Africa, for example, possesses no arboreal Anteaters; there are no Anteaters at all (of the order Edentata) in Australia, though there are plenty of ants for them to feed upon, and tropical conditions of climate prevail. But as in these cases the inference may be denied on the grounds that no experiments exist to prove or to disprove the assertion, the matter may be better emphasised by such cases as the introduction of the Rabbit into Australia, and various mammals, such as Goats, into oceanic islands. The plague caused by the former is a matter of notoriety. But although climate and conditions and animal inhabitants do not march accurately together, there is certainly some connexion between temperature and the range of animals. Mr. Lydekker writes on this point as follows: "The llama-like animals, respectively known as vicunas and guanacos, are met with in

company on the highlands of the Cordillera in Peru and Ecuador, but as we go farther south the latter are found on the plains of southern Argentina and Patagonia, as well as on the island of Tierra del Fuego at the sea level. Here then is a clear proof of the intimate connexion existing between temperature and station; the guanaco being an animal which can only live in cold or temperate climates, finds suitable conditions for its existence in tropical latitudes solely at a height of so many thousands of feet, although farther south it is able to thrive at the sea level." This, however, cannot be pushed too far—the world cannot be mapped out into areas bounded by parallels of temperature as was once attempted—since there are plenty of cases like that of the Tiger, which is as much at home in a tropical jungle as on the icy plains of Northern Asia.

Seeing that there are in many cases no climatic barriers to the spreading of a given race of animals over a larger area of distribution than it actually occupies, it becomes important to inquire why there are so many cases of restriction in range.

It is possible to see, at any rate, three causes which are responsible for a large number of such cases. In the first place, a given species of animal must have originated at a certain spot; its multiplication in individuals must always be a slow matter, since enemies, and untoward events generally, would conspire to check the natural multiplication by geometrical progression. A long time might therefore elapse before the species greatly extended its range. A restricted distribution may therefore, in some cases, mean a modern race. In the second place, there are definite physical barriers which check the migration of species. The terrestrial Mammalia cannot cross wide arms of the sea; that they can and do swim for considerable distances has been proved in several instances; but, as has been pointed out, it is unlikely that a purely terrestrial mammal would voluntarily swim out into an unknown sea. And then if it did, and successfully reached the opposite side, nothing would happen unless it were a pregnant female; or, if not pregnant, till a male swam very soon afterwards in exactly the same direction. Many travellers have told of floating islands, formed of torn-up trees and brushwood, which have been seen at the mouths of large rivers, with animal passengers upon them. These are, however, so much at the mercy of currents and storms,

that but little reliance can be placed on them as a means of transit; besides, here again, two individuals, or a pregnant female, would be required to effect a settlement on a foreign shore. The existence of oceanic islands is often urged as a proof of this inability to cross tracts of sea; even those which are comparatively near an extensive continent, such as, for example, Fernando Noronha in the Atlantic, are destitute of mammals (except, indeed, the ubiquitous Mouse, which is believed to have been carried there, often in company with the equally widely-spread Rat, in ships). This argument, however, is not so conclusive as might appear; it doubtless is in the case of far-distant islands. But the size of the islands has to be taken into account. For there are islands, such as the Galapagos, or, to take a less contested instance, some of the islands of the Malagasy Archipelago, undoubtedly continental, which have an exceedingly reduced number of mammals. An area of a certain size seems to be a necessity.

The converse of this is in many cases easy to show, that is, the wide range of animals when there are no marine barriers to stop their spreading. John Hunter, the celebrated anatomist and surgeon (not often quoted, however, as an authority upon geographical distribution), observes: "It is a curious circumstance in the natural history of animals to find most of the northern animals the same both on the continent of America and what is called the Old World, while those of the warmer parts of both continents are not so. Thus we find the bear, fox, wolf, elk, reindeer, ptarmigan, etc., in the northern parts of both. . . . The reason why the same animals are to be found in the northern parts is the nearness of the two continents. They are so near as to be within the power of accident to bring the animals, especially the large ones, from one continent to the other either on the ice or even by water. But the continents diverging from each other southward, so as to be at a very considerable distance from each other even beyond the flight of birds, is the reason why the quadrupeds are not the same."

There is no doubt, in fact, that the ocean is the most insuperable of all barriers to the dispersal of mammals. In a less degree mountain ranges and deserts are also barriers. The Desert of Sahara is a striking instance to the point; it separates two exceedingly different faunas.

A third cause of more or less limited range is the barrier due to competition. If the ground is already taken up, there is no room for new immigrants. There is obviously a limit to the number of Antelopes or Deer that can graze upon a given tract of grassy plain. These two groups of Ungulates illustrate the matter well: the Antelopes are African and Indian, especially the former, while Africa has no Deer at all; America, on the other hand, has plenty of Deer but no Antelopes, save the Prong-horn. The more nearly akin the two species or groups of species are, the fiercer will be the competition; for a near kinship will at least often imply similar habits, the need for similar food, and other likenesses which will prevent both from successfully occupying the same tract of country. The remarkable fauna of Australia is believed to afford an example of this. In that country the prevalent inhabitants are the Marsupials. The Monotremes are found there also, and nowhere else save in New Guinea and Tasmania. The remaining mammals are inconspicuous; they embrace a few Rodents and Bats, and the doubtfully indigenous Dingo-dog. Now the Marsupials are fitted to every variety of life. We have the grazing Kangaroos and Wallabies, the burrowing Wombats, the arboreal Phalangers, and the carnivorous Dasyures. In the second place, it is an unquestioned fact that the Marsupials are an older race than are the existing Eutherian mammals; they were the dominant mammals during the Secondary epoch. At that time they were more widely distributed than at present. In most parts of the world they are now absent, since they have been successfully ousted by the more highly organised groups of Eutheria. But at that period, when the higher Eutheria were in the ascendant, Australia and the islands to the north became cut off from Asia, and thus became freed from inroads of Eutheria, which were partly prevented by the physical barrier of the sea from effecting a settlement, and partly perhaps prevented owing to the ground being already taken up by the Marsupials. Likeness of habit gave the older inhabitants victory in the struggle for existence.

The general statements that have been here made are in accord with current opinion upon the factors of geographical distribution. But the past range of animals appears to be less consonant with the received views. In the Tertiary

period, groups of animals had often a far wider range than at present. To-day the Rhinoceroses are limited to Asia and Africa, and to quite limited parts of the former continent. In the past, these animals were abundant in Europe and North America. Wild Horses now have a range which is not widely different from that of the Rhinoceroses, save that they extend into the more northern regions of Asia. Their remains are abundant both in North and South America. The Hippopotamus, now confined to Africa, once ranged over Europe, Madagascar, and India. There were plenty of American and European Lemurs. Elephants were nearly world-wide in their range; and, in short, restricted distribution seems to be on the whole a characteristic of animals of the present day.

These statements, however, though perfectly true, must not lead to erroneous inferences. It is rather impressed upon the reader, in books which contain sections dealing with geographical distribution, that animals on the whole occupy more restricted areas at present than in the past. There are, however, plenty of examples of groups of extinct creatures which had, so far as we know, quite a restricted range. Thus the Toxodonts were purely South American, as were the Glyptodonts and some other forms. And, on the other hand, the Cervidae of to-day are as widely, if not more widely, distributed than at any other time. The Hares and Rabbits are now nearly universal in range; the Cats almost so. We meet with Bovidae, even excluding the Sheep and Goats, in all the four quarters of the globe, excluding only South America and, of course, Australia. The Camelidae are still common to both the Old and the New Worlds.

During certain periods of the Tertiary epoch it is true that there was more similarity between Europe and North America than there is at present. It would have been quite necessary to unite both into a Holarctic area, such as is now insisted upon by many; but the reasons for this union would then have been stronger. The fact is, however, that the closer resemblances were due to the larger number of families of animals which existed then than now; these have decayed away from both continents, and allowed the unlikenesses between the mammalian fauna of both to become evident. But the likenesses which still survive have led many to associate the two regions closely together.

So far as the history of a genus or family or larger division

can be traced, it results as a conclusion that from a given area of origin the group in question migrated in all directions where possible to a varying degree; it then died out in intervening tracts, or was left only in a certain part of its former and more extensive area of range.

Zoological Regions.—Seeing that each species of animal has its own definite range, it is clear that the earth's surface can be apportioned into divisions which are characterised by their animal inhabitants. We shall divide the earth into realms, which are the largest divisions; then into regions; and finally into subregions. It must be borne in mind that the various groups of the animal kingdom are of different ages, geologically speaking, and have therefore had less or more time, as the case may be, to settle down into their present distribution, and that different animals differ greatly in their rate of multiplication, their power of migration, and their susceptibility to the effectiveness of various natural and other barriers to distribution. It is not, therefore, possible to divide the world into realms and regions which shall express the facts of distribution of the entire animal kingdom. Such divisions, which are common in text-books of zoology having but a small section devoted to zoogeography, are at best mere approximations and averages; no good is gained by taking such a comprehensive view of the matter, as the essential object of subdividing the earth's surface is thereby lost sight of. The zoogeographical division of the earth which will be adopted here is that originally recommended by Dr. Blanford, and now accepted by a number of authorities. There are three "realms," to which a fourth may perhaps be added—though on negative grounds, and merely for the purpose of emphasising the parts of the world to which mammals have not gained access. The realms are again divisible into regions, at least in the case of one of them, and the regions may be again separated into more or less distinct subregions or provinces. The three primary divisions or realms which contain mammals are the Notogaean, including Australia and certain islands to the north of it; the Neogaean, or the South American continent and Central America; the Arctogaean, including the continents of North America, Europe, Asia, and Africa, together with the adjacent islands, such as the West Indies, East Indies (exclusive of those which fall within

the realm of Notogaea), and Madagascar; and finally, the realm of Antarctogaea or Atheriogaea, which embraces New Zealand, the Antarctic continent, and a series of islands such as South Georgia and Kerguelen, and possibly even the extreme south of Patagonia. This latter quarter of the globe will need no further reference, as it has no truly indigenous terrestrial mammalian inhabitants. We cannot include the Bats in this statement, as their distribution is due to different powers of extending their range, and to different barriers from those which govern the range of other groups of mammals.

(1) Notogaea.[1] This realm is characterised by the exclusive possession of the Monotremes:—that is to say, one of the two primary divisions of the Mammalia is absolutely restricted to this area. It contains, moreover, the vast majority of the Marsupials. Further, the realm of Notogaea is to be distinguished by the entire absence of the higher mammals, with the exception of a few small Rodents (The Bats are ignored for the reasons stated, and the Dingo is believed to have been an importation.) It cannot be disputed that this is a very distinctly-marked area of the earth's surface.

(2) Neogaea. The continent of South America has no Monotremes and only a few Marsupials, all of which, with the exception of *Caenolestes*, belong to the Polyprotodont division of that order, and to a peculiar family, Didelphyidae. The recent discovery of other fossil Marsupials, however, to some extent favours Huxley's view that Neogaea and Notogaea form one realm as opposed to the rest of the world. Besides this, Neogaea possesses the Edentata, which are found nowhere else;—that is, the division of the Edentata to which the name is now restricted by some authorities. It is also characterised by the nearly entire absence of the important order of Insectivora; and, as minor marks of distinction, by the absence of Antelopes, Oxen and Sheep, of the Ichneumon tribe, of Horses, and of Lemurs. It has the exclusive possession of the Hapalidae and Cebidae, and of several families of Rodents.

(3) Arctogaea. This vast realm is clearly capable of subdivision into four regions, which will be considered in detail later. In the meantime the points of likeness between these subdivisions is more marked than are either the resemblances or the

[1] This term is sometimes used in a wider sense; cf. vol. viii. p. 74.

differences of any one of them to either of the two realms which have just been defined. The two realms that have been discussed retain their distinctness from each other and from Arctogaea for a considerable way back into the Tertiary period. It is not until we reach very early Tertiary times that Edentates are met with in North America; and then it cannot be regarded as absolutely settled that the Ganodonta are really the forerunners of the Armadillos, Sloths, etc. Nor do we find Marsupials in Europe until far back in time, and at a corresponding period in North America. Indeed the fauna of South America in late Tertiary times was even more distinct than it is now; for then we had confined to that region the Toxodonts, Glyptodonts, *Macrauchenia*, and other forms, while in Australia there were still Marsupials. In late Tertiary times Europe and India were by no means so distinct from Africa as they are to-day. North America does not resemble the Old World quite so much as the subdivisions of the Old World resemble each other; but, as will be pointed out later, there are and were very substantial agreements. The Elephants, Rhinoceroses, Giraffe, Hippopotamus, *Orycteropus*, are now distinctively African or Indian animals; but all these genera, or at least families (in the case of the Giraffe), have occurred in Europe during quite recent times. *Lycaon* indeed, now confined to Africa, is thought to have had a European origin from its occurrence in caves there. The Hyaena and the Lion, certain members of the Horse tribe, Apes, and other animals, were also but are not now European.

India again, and the Oriental region generally, once possessed the Hippopotamus, the Chimpanzee, Giraffidae, the Antelopes, *Cobus*, *Hippotragus*, *Strepsiceros*, and *Orias*, which are now purely African animals. It shares at present with the Ethiopian region the Catarhines, including the Anthropoid Apes, the Lemurs, Tragulina (the genus *Dorcatherium* is also known from fossils in India), *Manis*, *Hyaena*, the Cheetah, Elephant, Rhinoceros, and the Ratel. There is, in fact, no order of mammals which is now absent from one of these three regions though present in the others, save the Lemurs, and they occurred in past times in Europe. The Tapir of India is known fossil in Europe, and the latter continent had its Monkeys and even Anthropoids. On the other hand, North America is more distinct. It has no Lemurs, Apes, Elephants, Rhinoceroses, Tapirs, Old World Edentates (Effo-

dientia), Viverridae, Horses, or Antelopes, excepting *Antilocapra*, a type of a separate division of Bovidae. But since several of these groups have been represented in recent times, no primary line of division can be profitably drawn.

Arctogaea as a whole may be characterised by both negative and positive characters. As negative features may be mentioned; —the entire absence of Edentates (*Necrodasypus* of Filhol is rather doubtful, see p. 164, n.), though a few crept up into the Nearctic region from Neogaea during past times; and of Hapalidae, Cebidae, and Marsupials, except an Opossum in North America. This realm has, on the other hand, all the Lemurs, all the Insectivores with the exception of the West Indian *Solenodon*, all the Proboscidea, Rhinoceroses, Horses, Deer, Antelopes, the last group including the Oxen and a variety of other important families. It is in fact the headquarters of all the Eutheria with the exception of the Edentata and Marsupials.

The subdivisions of this realm have been variously effected. The classical subdivisions are of course those of Mr. Sclater, who would recognise (1) the Nearctic, North America; (2) the Palaearctic, including Europe, Northern Asia, and Japan; (3) the Oriental, including Asia south of the Himalayas and the islands of the Malay Archipelago as far east as the Australian region; and (4) the Ethiopian, *i.e.* tropical Africa and Madagascar. Some would alter this by uniting America and the north of the Old World into a Holarctic region, separating off the southern parts of the North American continent into a Sonoran region. To some, the claims of Madagascar to form a separate region are convincing. To distinguish the boundaries of the several regions is a difficult task; they dovetail into each other on the frontiers with the complex curves of a puzzle-map. The difficulty has been grappled with by the suggestion of intermediate transitional areas; but this proceeding really doubles the difficulty, for there are then two frontiers to delimit in each case instead of only one. The animal inhabitants must be expected to mingle somewhat at the lines of junction of one region with another.

The Sonoran region does not appear to us to have great claims to recognition. It shows a mingling of southern with northern forms exactly as might be expected. An Armadillo and *Didelphys* have, as it is believed, invaded it from the Neogaeic realm; it possesses also the South American genera, *Dicotyles*, *Nasua*, *Cone-*

patus, Sigmodon. On the other hand, the Sonoran genera *Antilocapra, Cynomys, Procyon,* and the Insectivora *Blarina* and *Scapanus,* extend further north. Peculiar to this region are only six genera of Rodents, which seems an insufficient reason for raising the Sonoran province to the dignity of a region. Considered from the point of view of numbers of peculiar forms, the Thibetan subregion has more claims to distinction as a region; for confined to that area we have the genera *Nectogale, Aeluropus, Eupetaurus, Pantholops, Budorcas;* while by slightly extending its limits, a number of other peculiar forms might be added. Madagascar has distinctly more claims to regional division. Absolutely confined to it are eleven of the seventeen existing genera of Lemurs, the family Centetidae among the Insectivora, which contains seven genera, and another recently discovered and peculiar genus, *Geogale;* it has six peculiar genera of Viverridae; it has five peculiar genera of Rodents. In addition to this it is negatively characterised by the absence of the following typical African animals, Felidae, Proboscidea, Rhinocerotidae, Equidae, Monkeys, etc. It seems to be impossible to avoid allowing the rank of a region to this part of the world.

In separating the Nearctic from the Palaearctic region, stress must be laid rather upon the absence of Asiatic and European forms from North America than upon the existence in the northern half of the New World of many peculiar forms. Peculiar to the Nearctic are the Goat genus *Haploceros,* the Rodents *Erethizon, Zapus,* and the family Haplodontidae. The Mole genus *Condylura* is also restricted to this part of the New World. Even so it has more peculiar forms than the Sonoran. If we add to this the absence of Horses, Antelopes except *Antilocapra,* Pigs, Hyaenas, etc., there are strong grounds for retaining this division. It must be agreed, however, that it comes rather nearer to the Eurasian district than the latter does to the Oriental.

The Oriental region has many characteristic animals. It has among the Anthropoid Apes the Orangs and Gibbons; of Old World Apes it has confined to its own area the genera *Semnopithecus* and *Nasalis.* Of Lemurs there are *Loris* and *Nycticebus,* and *Tarsius,* representing a family of that order, or even a sub-order. The Galeopithecidae are entirely Malayan. There are many Rodent, Carnivorous, and Insectivorous genera; the Rhinoceroses and the Elephant of this region differ from those of Africa.

Tragulus concludes a sample from a very rich list of peculiar forms.

The Ethiopian region has also its Anthropoids, the Gorilla and the Chimpanzee, but they belong to genera or a genus different from those which include the Oriental forms. There are five peculiar genera of Cercopithecidae. The Lemurs restricted to this region are *Galago*, *Perodicticus* and *Arctocebus*. The peculiar Insectivorous families Macroscelidae and Chrysochloridae are only found here, besides many other peculiar genera. Africa is especially the home of Antelopes, and the Giraffe is not found now outside its borders. The Elephant and the Rhinoceroses are of different species from those of India. There are many peculiar Rodents and Ungulates.

CHAPTER III

THE POSSIBLE FORERUNNERS OF THE MAMMALIA

THE relationship of Mammals to Vertebrates lying below them in the scale, their origin in fact, is a much-debated question, with many attempted solutions. To enter into this large question in detail would involve a great deal of useless statement of arguments founded upon misleading or upon quite inaccurate "facts." It will perhaps be sufficient if we reflect here the current view most in vogue at the present, *i.e.* that which would refer the Mammalia to reptiles belonging to the extinct Permian and Triassic group of the Theromorpha (also called Anomodontia). These have been explored lately to a very large extent, and chiefly by Professor Seeley.[1] The very fact that a genus *Tritylodon*, only known by the forepart of the skull, has been called Mammalian and Anomodont by various authors, shows at least the difficulty of differentiating the two groups when the material for study is imperfect. As a matter of fact these Theromorpha are without doubt reptiles; they show, for example, a lower jaw formed out of several distinct pieces, of which the articular articulates with a fixed quadrate on the skull. They possess the characteristic reptilian bones, the "transverse," the pre- and post-frontals, and there are various other points of structure which leave no room for doubt as to their truly reptilian nature. There are, however, numerous indications of an evolution in the mammalian direction in all parts of the skeleton, to the more important of which some reference will be made here. It may be as well to clear the

[1] A series of papers in the *Phil. Trans.* for 1888-96, of which a useful abstract by Professor Osborn was published in the *American Naturalist*, 1898, p. 309; see also *Cambr. Nat. Hist.* viii. 1901, p. 303.

ground by mentioning the fact that among the Theromorpha four distinct types of reptiles are included, which are considered to form four orders, *i.e.* the Pareiasauri, the Theriodontia, the Anomodontia (Dicynodontia), and the Placodontia.

The first of these divisions includes what seem to be basal forms. These reptiles show numerous points of likeness to the Amphibian Labyrinthodonts.[1] On the other hand the third division, that of the Dicynodontia, are highly-specialised Theromorpha, from which no further evolution would appear to have been possible. Thus the dentition was either completely lost, or reduced to tusks as in *Dicynodon*. We need not therefore concern ourselves in the present volume with these Anomodonts. It is with the Theriodonts that our business lies. The very name, be it observed, is aptly chosen on the hypothesis to be explained here; but it is not only in the teeth that these reptiles show likenesses to the Theria or Mammals, but in almost every feature of their organisation. Unlike other reptiles, the Theromorpha in general were lifted comparatively high above the ground on legs of fair length and of mammalian relationship in the position of the segments of the limbs. The typical reptile grovels upon the earth with legs sprawling out, as indeed the very name suggests. One bar to the Theriodonts being on the direct line of mammalian ancestry has been urged as a preliminary difficulty, and that is their large size. The earliest undoubted mammals were small creatures, comparable to a Rat or a Mouse in size; whereas a good-sized Bear or a Wolf is a better standard of size for some of the best-known genera of Theriodonts. It has, however, been quite permissibly suggested that living in company with these large Theriodonts were less obtrusive genera, from which the mammals might have sprung. It is so familiar a fact that a given group of animals generally contains giants, dwarfs, and members of intermediate size, that this suggestion may almost be accepted as a fact. It need at least present no difficulties to us in our comparisons.

The most salient "mammalian" feature of the Theriodonts is the heterodonty of the teeth, the pattern of the "molars," and the limited number which constitute the series. The fact, too, that they are limited to the dentary bones below and to the

[1] Cf. vol. viii. p. 82.

maxillae and the premaxillae above, is a *sine qua non* for mammalian comparison. In the more basal Theromorpha the teeth are not so limited in position. Finally, to complete the remarkable mammalian resemblance of the teeth of these reptiles, it must be mentioned that in *Tritylodon* and *Diademodon* the roots of the molars, as we may fairly term them, though not actually divided after the mammalian fashion, were deeply marked by a groove, which suggests an incipient division or a fusion of two distinct roots. Some of these facts of structure may now be considered in further detail. As to the incisors and canines, it is sufficient to say that the numbers of the former, and the shape of the latter, are in perfect consonance with a derivation of the Mammalia from this group. The molar series can be divided into premolars and molars, at least in so far as regards their shape; for the anterior teeth are often smaller and less complicated than those which follow, as is often the case with the two series in mammals. The molar series also consist of teeth in close apposition to each other and separated from the canines by a diastema, which is a character of mammalian teeth. The fact that in the reptile *Cynognathus* and the mammal *Myrmecobius* there are nine of these molar teeth in each half of each jaw is perhaps not a point upon which it is desirable to dwell with too much weight; but the general fact that the molars are further reduced in some genera of Theriodontia than in that which has been mentioned, is clearly a matter of significance when the ancestry of the mammals is under consideration.

The most interesting fact about the molar series in the Theriodontia is that we meet with the two types of molars that occur in the mammals. *Cynognathus* and other genera have molars which consist of a main cusp, and of one cusp before and one after the main cusp; in fact these teeth are triconodont as in certain early mammals, a state of affairs which is believed by the "trituberculists" (see p. 56) to have preceded the tritubercular tooth. There are also "multitubercular" teeth, especially well developed in *Tritylodon*, where they exactly resemble those of certain Multituberculata, and whose structure originally led to the placing of *Tritylodon* among the mammals of that group. If there is any question about the mammalian nature of this fossil, there remain several other Theriodontia in which the multituberculism is well marked. It is so in *Trirhachodon*

and in *Diademodon* for instance. This incidentally lends some support to the idea that the Mammalia have been evolved from two sources, a way of looking at the origin of the group that will coincide with the views of some authors like the late Dr. Mivart, and will at the same time reconcile the trituberculists and the multituberculists. For we should then assume that the Eutheria and Triconodontia had originated from some such form as *Cynognathus;* and the Multituberculata and the existing Monotremes from some form like *Diademodon.* It is not of great use to point out that *Diademodon* is really of the trituberculate pattern, because in its molars, though multituberculate, the trituberculate main cones can be recognised; for that state of affairs could just as well have been brought about by a reduction from the multituberculate type. The skull of these Theriodonts shows some well-marked approximations to the mammalian type. There is in the first place a commencing consolidation and reduction of the individual bones, which is so distinguishing a feature of the mammalian skull as opposed to the skull of lower vertebrates. In *Cynognathus* the postorbital is fused with the jugal, and the supratemporal with the squamosal, forming apparently one bone. In the lower jaw the splenial is often reduced to the thinness of paper, thus indicating a commencing disappearance. In many Theromorpha the squamosal shares largely in the formation of the articular facet for the lower jaw, obviously an important mammalian characteristic; this is brought about by the reduction of the quadrate, which latter bone, moreover, acquires in certain particulars the appearance of the mammalian malleus, with which it is, according to many, homologous. But this subject has been already dealt with on page 26. A very pronounced likeness to the mammalian skull is that there are two occipital condyles. That this has been brought about by the further development of a tripartite condyle such as occurs in tortoises, and that by the suppression of the basi-occipital part, does not affect the resemblance to the mammalian skull; in fact it explains the origin of two condyles from the typical reptilian single condyle, and disposes of the necessity for believing, with Huxley and others, the Amphibia to be on the main line of mammalian evolution on account of their two condyles. The general aspect of the skull in *Cynognathus* has been com-

pared to that "of *Thylacinus* or *Dissacus*." No one can examine the actual sketches of the skull of that Theriodont without endorsing that opinion. As a curious detailed point of likeness to certain Mammalia may be mentioned "a small descending process of the malar bone, which may be a diminutive representative of the descending element of the malar seen in *Elotherium, Nototherium, Diprotodon, Macropus*, certain Edentata, such as *Glyptodon, Megatherium, Mylodon, Bradypus*, but unparalleled so far as I am aware in fossil reptiles." (Osborn.) The zoologist cannot help being impressed with the significance of small details of similarity, which do not seem to be due in any way to surrounding conditions of life, and thus referable to mere convergence, like the fish-like form of Whales and Seals.

The rest of the skeleton of the Theriodontia is by no means so well known as the skull and teeth. But from what is known, other mammalian characters can be pointed out. Perhaps the most striking mammalian feature is to be found in the scapula of *Cynognathus*. It is in this creature somewhat narrow and elongated; but it has a well-marked spine, ending in a hooked acromion. Now it is to be noted in support, so far, of the diphyletic origin of mammals, that in the Monotreme, as in Whales indeed, the spine forms the anterior border of the scapula, and is coincident with it, there being thus no prescapula at all in the Monotreme, and only a trace of it in certain Whales.[1] Whether the multituberculate *Tritylodon* or *Diademodon* had a scapula after the Monotreme pattern is not known; but it is clear that the scapula of the triconodont *Cynognathus* is quite after the pattern of the Eutherian scapula. Furthermore, Professor Seeley is of opinion that the coracoid was relatively small, and indeed smaller than the same bone in Edentates, and *a fortiori* than in Monotremes. Another fact of structure which points also, possibly, in the direction of a diphyletic origin for the Mammalia, is the double-headed ribs of *Cynognathus*. As is well known, the ribs of the Monotremata have only the central head, the capitulum.

As a general mark of affinity with mammals the reduction of the intercentra in *Cynognathus* may be noted, and also the existence of a small though perfectly obvious obturator-foramen, separating the pubis from the ischium. There are further details

[1] It may be necessary to exclude the Whales from the comparison.

which tend in the same direction. And we shall probably not go far wrong in the present state of our knowledge if we assign the origin of the mammals to some type which would be included in the order Theriodontia or at least in the sub-class Theromorpha.

CHAPTER IV

THE DAWN OF MAMMALIAN LIFE

THE animals that we considered in the last chapter, though showing certain unmistakable likenesses to the mammals, are nevertheless unquestionably not mammals but reptiles. In the Triassic strata, however, we first meet with the remains of undoubted mammals. The Mammalia first appeared upon the earth in a tentative and hesitating way: they had not cast off many of the characters of their supposed reptilian forefathers; they shrank from observation and destruction by their small size, and apparently, so far at any rate as their teeth afford a clue, by an omnivorous diet. The world abounded at that period in large and carnivorous reptiles, which may indeed have been the principal enemies with which the first mammals had to cope. These early mammals lingered on to so late a period as the Eocene; but the majority of the genera were Triassic, Jurassic, and Cretaceous. Certain of the primitive mammalian forms have been referred to the Marsupials, and their resemblances to the Monotremata have also been pointed out. The current view of the present time, however, is that they form a special order, which may possibly have embraced the ancestors of both Marsupials and Monotremes; for it is reasonable to explain in this way the combination of characters of these two orders which they present. For this group the name Allotheria has been proposed by Marsh, and Multituberculata by Cope; the latter term is the less suitable, in that the Monotremata (*Ornithorhynchus*) are also "multituberculate." The group is known in a very imperfect fashion. The remains are but few and fragmentary; and for the most part we have only a few teeth to speculate upon. This is natural enough, for the harder teeth might easily be supposed to

have resisted the decay which would more readily affect the softer bones. Where there are bones it is frequently the lower jaw alone which has been preserved for us—a bone which has also been preserved in the case of some of the contemporary Marsupials.

It has been pointed out (from the observation of dead dogs floating in canals) that the lower jaw is occasionally detached from the carcase. It is the most readily separable part which contains a skeleton. It may be, therefore, that the remains of these early mammals, floating down some river to the sea, may have lost their jaws while in the river, or at furthest in the shallow waters of the sea, the rest of the carcase floating out to a greater distance, and being finally entombed in the stomach of some carnivorous fish, or in the mud at the bottom of a deep ocean, which has never since seen the light.

The characters of this group are really more those of the Monotremata than of the Marsupials. The undoubted likeness which their molar teeth show to the temporary teeth of the Platypus have already been commented upon. Like the Monotremes the Allotheria appear to have possessed a large and independent coracoid; the evidence for this rests upon the discovery of the lower end of a scapula of *Camptomus*, a Cretaceous genus from North America upon which there is a distinct facet for the articulation of what can have been nothing else than a coracoid. On the other hand they differ from the Monotremata by the presence of incisor teeth which were Rodent-like in form, and not very different from those of certain Marsupials. This point of difference cannot be regarded as of very first-rate importance; no one would relegate the Sloth and the Armadillo to different orders on account of their tooth differences, which are about on a par with those to which we have just referred. It seems indeed likely that it will be ultimately necessary to rub out the boundary line which now divides the Allotheria and the Monotremata.

The Plagiaulacidae are unquestionably mammals, and they are placed by most naturalists in this at present uncertain group of Multituberculata, which will be retained here in deference to the distinguished authorities who have instituted the group, though there are but few characters by which it can be defined. This family though appearing in the Trias, extends down in time to the Eocene. The type-genus, that which has given its name to

the family, is *Plagiaulax*. As it is not Triassic, the consideration of its characters will be deferred until later. *Microlestes* is a Rhaetic genus, known from rocks in Germany and England; but it is entirely based upon molar teeth. *M. antiquus* has a two-rooted molar of an elongated form with a row of tubercles on either side of a median groove, which traverses the long axis of the tooth. To some extent the teeth of the ancient form resemble those of *Ornithorhynchus*. *Microlestes* has been sometimes spoken of as a Marsupial, but Mr. Tomes[1] has found that it does not show one very universal character of the Marsupial teeth: it has not those continuations of the dentinal tubes which traverse the enamel in all Marsupials that have been examined with the sole exception of the Wombat.

The rarity of the remains of mammals in these earliest rocks of the Secondary epoch has been accounted for in another way from that which has been suggested above. It may be that the group Mammalia was not evolved in Europe at all, and that the stray remains which have been found in that continent represent the fragmentary remnants of a few scattered immigrants which heralded the later invasion of more numerous genera during the Jurassic period.

The Mammals of the Jurassic Period.—Some of the Allotheria or Multituberculata described in the last section occur in the rocks of this early part of the Secondary epoch. They are doubtful in position, as already stated; some of them indeed, as for instance *Tritylodon* and *Dromatherium*, are possibly not mammals at all, while the remainder probably belong to a non-existent order of mammals. Along with these dubious creatures are the fragmentary remains of small animals which are not merely mammals, but in all probability definitely Marsupials. It is true that here again we have little beyond lower jaws and teeth to deal with; so that there may be less certainty in referring them to the Marsupials than appears to be the opinion of the majority of Palaeontologists.

Professor Osborn in fact considers that the Mesozoic Mammals consist of three groups: (1) The Multituberculata, including the Bolodontidae, Stereognathidae, Plagiaulacidae, Polymastodontidae, and possibly the Tritylodontidae (which, however, are regarded by him and by others as more probably reptiles of the

[1] *Dental Anatomy*, 5th ed 1898, p. 304.

Theromorphous group). (2) The Triconodonta, which were Marsupials, though in all probability with a complete succession of teeth and with an allantoic placentation. This group will include the genera *Phascolotherium* and *Amphilestes*, as well as *Triconodon* and *Spalacotherium*. Finally we have (3) the Trituberculata (or Insectivora Primitiva) with the genera *Amphitherium*, *Peramus*, *Amblotherium*, *Stylacodon*, and *Dryolestes*.

We shall take these three groups in order. The Multituberculata have already been to some extent defined, if such a word can be used to express the summation of the very scanty information at our disposal. Of this group, *Plagiaulax* is a genus which occurs in the Purbeck beds; it is only known by lower jaws implying an animal of the size of a Rat or rather smaller. The jaws have in front a large incisor which looks Rodent-like, and also like those of the Diprotodont Marsupials; but it is held that these teeth did not grow from persistent pulps, and there is in any case no anterior thickened coating of enamel. Canines are absent; the diastema is followed by four premolars increasing progressively in size and possessing somewhat complicated grinding surfaces. These surfaces are formed by several obliquely-set ridges. The succeeding teeth are termed molars on account of their difference in structure, and there are but two of them on each side. The molars are of a pattern common in the Multituberculata; the centre is hollowed, and the raised rim is beset by tubercles. Other Jurassic genera of Multituberculates are *Bolodon*, *Allodon*, and *Stereognathus*. All of these possess the same multituberculate molars.

Of the Triconodonta the type-genus is *Triconodon*. This genus is better known than most Jurassic mammals, since both the upper and the lower dentition have been described. It appears to have possessed the typical Eutherian dentition of forty-four teeth, to which a fourth molar is added in some species. The great difference between the molars and premolars argues a complete tooth-change. The genus is American as well as European.

Spalacotherium has more molars, five or six.

Phascolotherium bucklandi, on the other hand, is a much older type in the form of its teeth. There are, however, not so many of them as in *Amphitherium*; *Phascolotherium* has but two premolars and five molars, making a total of forty-eight teeth. The teeth are of the triconodont form, the three cusps being in line, and the middle one the largest.

Amphilestes has teeth of the same pattern but has more of them, the premolars and molars being respectively four and five. All these animals had the lower jaw inflected. Whether they are all Marsupials or not, it is clear that *Phascolotherium* and *Amphilestes* should be united and placed away from *Amphitherium* on account of the more primitive form of their teeth.

We next come to the Trituberculata.

Among the most celebrated of these remains are a few jaws discovered in the Stonesfield slates near Oxford, and examined by Buckland, Cuvier, and some of the most eminent naturalists of the beginning of the last century. These jaws have been lately submitted to a careful re-examination by Mr. Goodrich,[1] who has increased our knowledge of the subject by exposing from the rocky matrix in which the jaws lie fresh details of their structure; it is probable therefore that now all that there is to be learnt from these specimens has been recorded.

Amphitherium prevostii was a creature about the size of a Rat. Its jaw was first brought to Dean Buckland about the year 1814, and described six years later. Buckland thought the jaw to be that of an Opossum, an opinion in which Cuvier concurred. The jaw, however, is marked by a groove running along its length, and this groove was regarded by de Blainville as evidence of the composition of the jaw out of more than one element, which would naturally lead to its being regarded as the jaw of a reptile.[2] This species and another named after Sir Richard Owen have a dental formula which, like that of the Marsupials, is large as compared with that of the Placental mammals; it runs: I 4, C 1, Pm 5, M 6—*i.e.* 64 teeth altogether. This is a larger number than we find in any existing Marsupial. But as in Marsupials, and in certain Insectivora also, the angle of the jaw is inflected. These teeth are of the tritubercular pattern with a "heel." They are in fact closely like those of the living *Myrmecobius;* but not, it should be remarked, unlike those of certain Insectivora.

The Mammals of the Cretaceous Period.—At one time there was a totally inexplicable gap between the Jurassic and the basal Eocene, a series of strata which occupy an enormous expanse of time in the history of the earth having appeared to

[1] "On the Fossil Mammalia from the Stonesfield Slate," *Quart. Journ. Micr. Sci.* xxxv. 1894, p. 407.

[2] This groove has been found in the existing *Myrmecobius*, see p. 154.

be devoid of mammalian remains. This gap, however, has been filled up by the discovery of mammalian remains in the North American Laramie formation, which seems to be clearly of Cretaceous age. Furthermore, it is held by some that the Purbeck beds are more properly to be placed with the Cretaceous, which would then necessitate the consideration under the present heading of some of the types already dealt with; and if, as is suggested in the following section, the lowest so-called Eocene beds are really referable to the Cretaceous, there is no lack of mammalian remains in that period. And, moreover, it was in that case the Cretaceous period which witnessed the evolution of the existing orders of Placental mammals. Otherwise the mammalian remains of the Cretaceous agree with those of the Jurassic. We find remains of the Multituberculata in fragments of Plagiaulacidae and Polymastodontidae. *Ptilodus* is a genus which has two premolars; and *Meniscoessus* is another multituberculate from the same Laramie formation. The other detached fragments of mammals are thought by Osborn to represent both Placentals and Marsupials.

The Mammals of the Tertiary Period.—Unless the lowest beds of the earliest Tertiary period, the Eocene, such as the Torrejon of North America, should be in reality referred to the Cretaceous, there is no evidence that the modern groups of Mammalia existed before the present epoch of the earth's history. It is probable, however, that the Eutheria as a group were Mesozoic. The fossil jaws that have been considered in the last chapter may quite probably be primitive Eutherians, or even divisible, as believed by Professor Osborn, into Marsupials and Insectivores. In the Tertiary, however, apart from the question as to the nature of the Puerco and Torrejon formations, and as to certain South American strata whose fossil contents have been investigated by Professor Ameghino, we find the first traces of mammals definitely referable to existing orders, or to be distinctly compared with existing orders. Since, however, representatives of types which have obvious relationships to modern types appear in considerable profusion in the very earliest strata of the Eocene, it seems clear that much remains to be discovered in beds earlier than these. Confining ourselves, however, to facts and to comparisons which can be made on more than a few lower jaws and scattered teeth, which is practically all that we

possess of earlier mammals, we must arrive at the general conclusion that two of the existing larger groups of the Eutherian, non-Marsupial, mammals were differentiated at quite the beginning of the Eocene, and were represented by forms from which it is possible to derive at least the existing Carnivora, Insectivora, Artiodactyla, and Perissodactyla. These were the Creodonta and the Ungulate Condylarthra. In addition to these we may enumerate as very early types the Lemuroidea, represented by such forms as *Indrodon* in the New World, and (though later) by *Necrolemur*, etc., in the Old World, and the Edentata, if we are to allow as their ancestors the Ganodonta.

The early Eocene strata also contain representatives of at least one order, the Amblypoda, which increased subsequently, but has died out without descendants, unless we are to believe with some that the Elephants are to be derived from these Eocene "pachyderms." In later Eocene times the great majority of the existing orders, and even subdivisions of orders, are to be met with; and there are in addition such totally extinct orders as the Typotheria, Ancylopoda, and Tillodontia. Coupled with this gradual specialisation in the orders of Eutherian mammals, there is naturally a vast increase in the number of generic and family types. This culminates perhaps in the Miocene, from which time there has been a gradual decline in mammalian variety, so that it is justly said that we live now in an epoch which is impoverished of mammals. This gradual decay has persisted until to-day, as is witnessed by the extinction of the Rhytina and the Quagga, and the growing rarity of the White Rhinoceros and the American Bison.

The early Eutherian stock consisted of small mammals with small heads and slender, long tails. The limbs were pentadactyle, ensheathed in claws or broader hoofs. The fore-limbs may have been partly prehensile. The teeth were forty-four, completely differentiated into incisors, canines, molars, and premolars; and there appears to have been a complete diphyodontism. The canines were not greatly enlarged, and no diastema separated any of the teeth. The molars were bunodont or of a more cutting pattern, with some five or six tubercles. These animals were, moreover, very small-brained. This early stock is represented by Creodont and Condylarthrous animals, the exact boundaries between which are hardly marked in the

very early types. Professor Osborn has argued that from this early Eutherian stock there were two waves of progress, or, as he expresses it, "two great centres of functional radiation." [1]

The first was largely ineffective, the second has produced all the Eutherian orders of to-day. These two divisions are termed by him "Mesoplacentalia" and "Cenoplacentalia." [1] The first division embraces the Amblypoda and their descendants the Coryphodonts and Dinocerata, many of the Condylarthra, the bulk of the Creodonts and the Tillodonts. These creatures persisted for a time, but died out in the Miocene. They were mainly distinguished by the smallness of their brain; the great specialisation of structure which they exhibit having left that organ unaffected, and therefore tending in the long run to render them unable to cope with changes in the inorganic and organic world. The successful division of the primitive Eutheria comprises the groups which exist at the present day, and is not connected directly with those small-brained Mesoplacentals; it has apparently originated, however, from the least specialised of their ancestors. Professor Osborn thinks, moreover, that the Lemurs and the Insectivores are persistent descendants of the earlier wave of Eutherian life. It appears in fact as if Nature had created the existing Ungulate, Unguiculate, and other types on a defective plan, and, instead of mending them to suit more modern requirements, had evolved an entirely new set of similarly-organised types from some of the more ancient and plastic forms remaining over. The Marsupials may be the only group of the early wave remaining, and they have been able to hold their own for the geological reason that Australia was early cut off from communication with the rest of the world. That they are disappearing seems to be shown by their gradual diminution as we pass from Australia towards the continent of Asia, through the islands of the Malay Archipelago. Competition has here decimated them, as it may do in the remote future in Australia.

It is often said, but with some looseness of statement, that ancient quadrupeds are huger than their modern representatives. This statement is partly true in fact, but largely wrong in implication. For it suggests that—and the suggestion is often expressed in books that are not authoritative—huge animals

[1] *Trans. New York Acad. Sci.* xiii. 1894, p. 234.

have left a dwarfish offspring; that there were giants of old, and that there is a puny race to-day. As a matter of fact, the study of the gradual evolution of the early Tertiary Mammalia into their descendants of later times shows very plainly the truth of this interesting generalisation: That the primitive types were all small creatures, and that in those instances where we can trace a pedigree, there was a gradual increase in size up to a point where greater increase led to extinction. We point out later on a number of facts illustrating this matter in detail. It has been ascertained, for instance, that the pedigree of the Horses, the Camels, the Rhinoceroses, and many other groups, commences with small forms and culminates in large ones. It may be urged that such animals as the Tapir are to-day smallish forms, and that related to them in the past were the gigantic Titanotheres; but in this and similar cases it will be found that the extinct giants were not in the direct line of pedigree, but represented side-branches which waxed huge on their own account and then disappeared.

CHAPTER V

THE EXISTING ORDERS OF MAMMALS

PROTOTHERIA—MONOTREMATA

APART from those creatures whose fragmentary remains have been considered in the last chapter, and which belong to the earliest of mammaliferous strata, the remains of Mammalia are all referable to existing orders. In the pages which follow we shall therefore deal with the actual representatives of living families side by side with their extinct relatives. The existing orders of Mammalia, together with those of their fossil allies, can be plainly divided into two great subdivisions, or, as we shall term them, sub-classes; the Mammalia as a whole being termed a class of the Vertebrata comparable with the class Reptilia, etc. It has been usual, owing to the initiative of Professor Huxley, to divide the Mammalia into three divisions of primary importance. We shall adduce reasons later for not accepting this mode of division, but that which allows of only two primary divisions. These two divisions are (1) Prototheria and (2) Eutheria. Whether the Multituberculata, Trituberculata, and Triconodonta, considered in the last chapter, are really to be distributed among these two sub-classes is a matter upon which it is possible to form an opinion, but not to dogmatise. The Prototheria stand at the base of the mammalian series, and present many likenesses to the Sauropsida; the Eutheria are the animals which are most fully differentiated as mammals. We shall commence with

SUB-CLASS I.—PROTOTHERIA.

To this group belongs the order Monotremata, and possibly also the so-called Allotheria or Multituberculata. As, however,

the latter are only known from very fragmentary remains, which are not sufficient to determine the systematic position of the animals of which they are fragments, I have not thought it worth while to attempt a serious definition of the order Multituberculata. I have introduced a short account of the principal facts which are known concerning the creatures grouped together under this name into the historical sketch of the progress of mammalian life in Chapter IV. As to the Monotremata, there is no question that they are entitled to rank in a group equivalent to that including all other mammals of which we have sufficient knowledge to construct a classificatory scheme. There have been, indeed, naturalists, such as Meckel, who would altogether deny the mammalian rank of these creatures.

The Monotremata or Ornithodelphia may be thus defined:—

Mammalia with no teats, but with a temporary pouch in which the young are hatched, or to which they are transferred after hatching, and into which open the ducts of the mammary glands. An anterior abdominal vein, or at least the membrane supporting it, persists throughout the abdominal cavity. Heart with an incomplete and largely fleshy right auriculo-ventricular valve. Brain without a corpus callosum. Shoulder girdle with a large coracoid reaching the sternum; clavicles and an inter-clavicle present. There are "marsupial" or epipubic bones attached to the pelvis. Vertebrae with no epiphyses for the most part. Ribs with only capitulum and no tuberculum. Mammary glands of the sudoriparous and not the sebaceous type of epidermic gland.[1] Oviparous, with a large-yolked and meroblastic ovum, enclosed within a follicle of two rows of cells.

To call these animals Mammalia is of course an abuse of the meaning of that word in one sense, but it is not in another; since the pouch of these Monotremes is, as has been explained elsewhere (p. 16), the real equivalent of a teat, and not of the pouch of the Marsupials.

The most salient characteristic of this group of mammals in the estimation of their position in the vertebrate series is not so much the fact that they are oviparous as that the eggs are large-yolked, and develop therefore, so far as regards their early stages, after the fashion of the egg of a reptile. The laying

[1] Gegenbaur, *Zur Kenntniss der Mammarorgane der Monotremen*, Leipzig, 1886.

of eggs, or at least ovoviviparity, would follow from the structure of the egg, since the abundance of yolk would do away with the necessity for a placenta. That the eggs had this Saurian characteristic was first definitely made known by Professor Poulton [1] for *Ornithorhynchus*, and his results were confirmed later for *Echidna*.[2] The structure of the eggs has, however, already been dealt with on p. 72. The fact that these animals lay eggs appears to have been known for a very long time, though rediscovered so lately as 1884 by Mr. Caldwell.[3] In connexion with the structure of the ova, the ovaries themselves and the oviducts are built upon the Sauropsidan plan. In the male the testes retain the primitive abdominal position. The fact that the urinary and genital products escape by means of their ducts into a chamber which also receives the end of the alimentary tract is not a distinctive feature of this group, inasmuch as it is seen in the Marsupials, and also in certain low Eutheria, such as the Beaver and other Rodents, and a few Insectivores. As to external features, the Monotremata show certain archaic characters. The unspecialised arrangement of the mammary glands has already been described. These animals are plantigrade, if the term may be used also to describe the aquatic *Ornithorhynchus*. The ears are absolutely destitute of a conch. The remarkable spur upon the hind-legs furnished with a gland, which is more marked in the male, and indeed disappears in the female of *Ornithorhynchus*, is a structure which argues the specialised condition of these two modern representatives of what must have been a large order in the past.

The skeleton shows numerous ancient characteristics. In the skull there is no demarcation of the orbit from the temporal fossa, a feature widely found in archaic mammals. The tympanic remains as a slender ring, there being no auditory bulla formed either from this or from any other bone. The malleus and incus are large, and thus reminiscent of the quadrate and articular bone of reptiles. In the lower jaw the absence of a marked coronoid process, and the absence of a firm ossification at the meeting of the two rami, may be a primitive state of

[1] *Quart. Journ. Micr. Sci.* xx[illegible] 1884, p. 124.

[2] Beddard, *Proc. Roy. Phys.* [illegible] *Edinb.* viii. 1885, p. 354.

[3] See *Phil. Trans.* clxxviii. 1887; where the literature of the subject is fully cited.

affairs. It must be remembered, however, that the Cetacea show the same characters, though it is possible that they too are developed from a low mammalian stock. In the vertebral column we find the typical mammalian seven cervicals; but those characteristically mammalian structures the epiphyses are

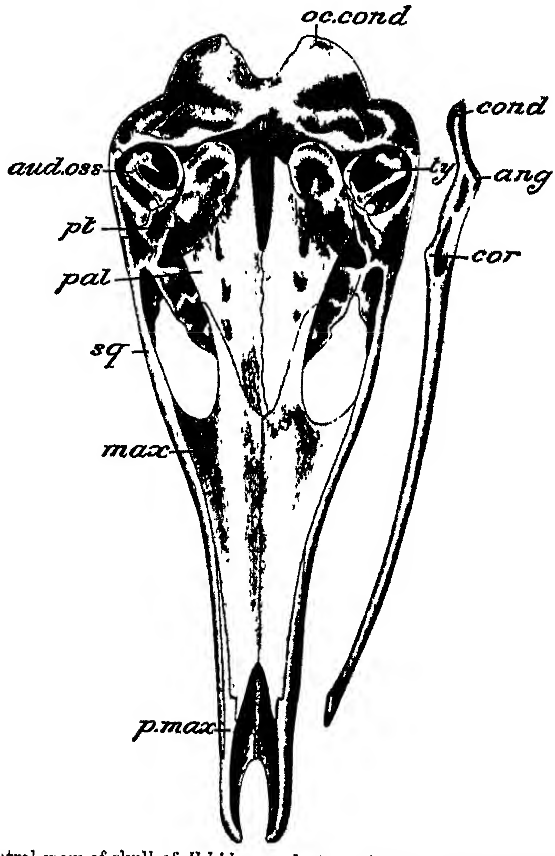

FIG. 51.—Ventral view of skull of *Echidna aculeata*, and right half of mandible. *ang*, Angle of mandible; *aud.oss*, auditory ossicles; *cond*, condyle of mandible; *cor*, coronoid process; *max*, maxilla; *oc.cond*, occipital condyle; *pal*, palatine; *p.max*, premaxilla; *pt*, pterygoid; *sq*, squamosal; *ty*, tympanic ring. (After Parker and Haswell.)

totally absent in *Echidna*, and only to be seen in the tail-region in *Ornithorhynchus*. In having only the capitular head to the ribs, these mammals are evidently far removed from all other mammals, and are even more reptilian than the Theromorphous reptiles. The large clavicles and the interclavicle (Fig. 52,

p. 109) are characteristic of the group, and the latter bone is peculiar to the Monotremata among mammals. So, too, is the large coracoid. In the scapula there is a spine which coincides with the anterior border of that bone. The arrangement of the muscles in this region proves conclusively that this projection is the homologue of the spine and the acromion of other mammals. Here, again, we have a point of likeness to the Cetacea.[1] In the pelvis the acetabulum is perforate (in *Echidna*), as in Sauropsida.

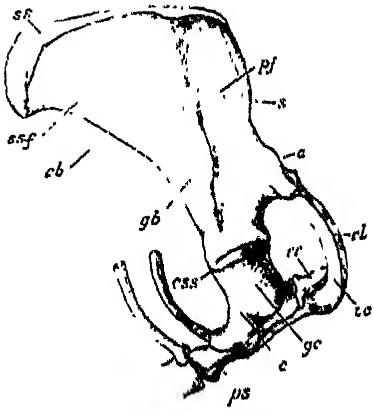

FIG. 52.—Side view of right half of the shoulder girdle of a young Echidna (*Echidna aculeata*). × 1. *a*, Acromion; *c*, coracoid; *cb*, coracoid border; *cl*, clavicle; *css*, coraco-scapular suture; *ec*, epicoracoid; *gb*, glenoid border; *gc*, glenoid cavity; *ic*, interclavicle; *pf*, postscapular fossa; *ps*, presternum; *s*, spine; *ss*, suprascapular epiphysis; *ssf*, subscapular fossa. (From Flower's *Osteology*.)

Considering the numerous very archaic features which the general structure of this group displays, it is surprising to find how typically mammalian they are in certain other peculiarities. The mammalian diaphragm, one of the distinguishing features of the class, is perfectly normal in the Monotremata. The alimentary canal shows no great divergences from the normal structure. The stomach is almost globular, with a projecting pyloric region in *Ornithorhynchus*; the intestine is divided into a "small" and "large" intestine by a slender caecum. The liver has the subdivisions that this organ usually shows in the Mammalia. However, the presence of the ventral mesentery and of the abdominal vein in *Echidna* and *Ornithorhynchus* has already been mentioned as a distinctive character. The peculiar and apparently partly primitive valve of the right ventricle has been described above (see p. 66). The brain is in most respects mammalian in its characters, but naturally shows some important differences. Dr. Elliot Smith, who has most recently studied this question,[2] is of opinion that the size of the cerebral hemispheres is not at all reptilian; indeed, it "greatly exceeds that of

[1] Muscular insertions and attachments do not, however, altogether support the comparison.

[2] *Journ. Anat. Phys.* 1899, p. 309.

many other mammals." In *Echidna*, too, but not in *Ornithorhynchus*, the hemispheres are well convoluted, though the arrangement of these convolutions cannot be brought into line with what is known concerning the convolutions upon the hemispheres of other mammals. It had been stated that in these animals, at least in *Echidna*, there were only two optic lobes, as in lower vertebrates, instead of the mammalian four. The late Sir W. H. Flower set this matter at rest,[1] and showed that *Echidna* was in this respect typically mammalian. The absence of the corpus callosum is one of the principal features separating the Monotremes from other mammals.

FIG. 53.—Brain of *Echidna aculeata*, dorsal view. (Nat. size) (From Parker and Haswell's *Zoology*.)

The Monotremata are represented to-day by two types, *Ornithorhynchus* and *Echidna*, which are no doubt worthy of being placed in separate families. Fossil remains of the group (apart from the problematical Multituberculata) are only known from Pleistocene times in Australia, and consist of the bones of a large species of *Echidna*, and some fragments of *Ornithorhynchus*, indicating a smaller animal than the living Platypus.

Fam. 1. Echidnidae.—This family contains two genera, of which *Echidna* is the older and much the better known. The skin is abundantly covered with spines, with which are mingled hairs. The snout is tapering, the tail rudimentary, and the fingers and toes five in number. The spur and gland upon the calcaneum are smaller than in *Ornithorhynchus*. The claws are very strong, serving to tear open the ants' nests, upon the inhabitants of which the Echidna feeds, licking them up with a long extensile tongue like that of *Myrmecophaga*. In relation to this habit the salivary glands are enormously developed, and indeed the animal has been confounded with *Myrmecophaga*,[2] as the vernacular name "Australian Anteater" exemplifies.

[1] *Proc. Zool. Soc.* 1864, p. 18.

[2] *Myrmecophaga aculeata* was the name given by Shaw.

In the skull the Echidna differs from *Ornithorhynchus* in the greater extension backwards of the palatines and the larger size of the pterygoids. The extent and relations of these bones to each other is not at all unlike that which obtains in many Whales. The premaxillae show traces of the same divergence followed by convergence of their ends that is seen in the Platypus. There are only sixteen pairs of ribs, and either three or four lumbar vertebrae. *Echidna* has no trace of teeth, and there are no horny pads which take their place; the mouth is as edentulous as in the true American Anteaters. The brain (Fig. 53) is marked by sulci, contrary to what we find in *Ornithorhynchus*. The genus has been divided into three species,

FIG. 54. Australian Anteater. *Echidna aculeata*. × ⅓.

but it is doubtful whether more than one can be allowed, which ranges from Australia through the Papuan region. While there is but one species of true *Echidna*, a New Guinea species must clearly be referred to a distinct genus *Proechidna*.[1] This animal is to be distinguished by the fact that there are usually but three toes on each foot. But there are copious rudiments of the other phalanges, upon which claws are sometimes developed. The beak is curved downwards, and the back is rather arched; the whole animal has the most singular likeness to an Elephant! The ribs are increased by one pair, and there are four lumbar vertebrae. The one species is named *P. bruijnii*. The Hon. W. Rothschild[2] distinguishes a form *P. nigroaculeata*, which is allowed by Mr. Lydekker.

[1] *Zaglossus* has apparently priority as a name; but *Proechidna* is better known.

[2] *Proc. Zool. Soc.* 1892, p. 545.

The Echidna feeds like anteaters, by thrusting its tongue into an ant-hill, and waiting until it is covered with indignant and marauding ants, which are then swallowed. But this animal also devours worms and insects, which are extracted from their hiding-places by the tongue. It is mainly nocturnal, and prefers the seclusion of the densest scrubs of the bush, or rocky spots where it is free from intrusion. Dr. Semon did not find that the spur of this animal was used at all in self-defence; but he thinks that possibly the weapon may be used, in the breeding season only, in the combats of the males for the females, when perhaps, as has been shown to be the case in *Ornithorhynchus*, the gland attached to it produces a poisonous secretion.

The egg, as it appears, is transferred to the pouch by the mouth of the mother; the shell is broken by the emerging young one, which has an egg-breaking tubercle on its snout for this purpose; the mother removes the shell. When the young has attained a certain size, the mother removes it from the pouch, but takes it in from time to time to suckle it. When on her nightly rambles the young one is left in a burrow dug for the purpose. Dr. Semon was able, from his own observations, to substantiate this act of intelligence on the part of the Echidna. It is well known that the temperature of the Monotremes is less than that of higher mammals; in addition to this fact Dr Semon found that the range of variation of temperature in the Echidna was as much as 13 degrees or more. It is thus intermediate between the "poikilothermal" reptiles and the "homoeothermal" mammals.

Fam. 2. Ornithorhynchidae.—There is no need to attempt to define this family, since it contains but one genus *Ornithorhynchus*, with but one species, *O. anatinus*. The general aspect of the animal is well known. It is covered with dense fur of a blackish brown colour; the limbs are short and five-toed, the toes being webbed. The tail is longish and broad, being flattened from above downwards. The webbing on the anterior toes considerably outdistances the tips of the claws, as in the Seals. But this is not the case with the hind-feet. The "beak," which is broad and flat, and does actually suggest that of a duck, is not covered with horn, as is often stated, but with a fine, soft, sensitive, naked skin, which abounds in sense-organs of a tactile nature. As to characters derived from the skeleton, *Ornithorhynchus* has seven-

teen pairs of ribs and only two lumbar vertebrae. The skull is expanded in front, and the bill is supported by two, at first diverging, and then converging, premaxillae. Between them is the famous "dumb-bell shaped bone," which is believed to be the representative of the reptilian prevomer. The pterygoids are smaller than in *Echidna*, and the hard palate does not extend so far back as in that genus. The brain of this genus is smooth.

The discovery of the real teeth of *Ornithorhynchus* only dates from the year 1888, when they were found by Professor Poulton[1] in an embryo. Later Mr. Thomas found[2] that the teeth persist

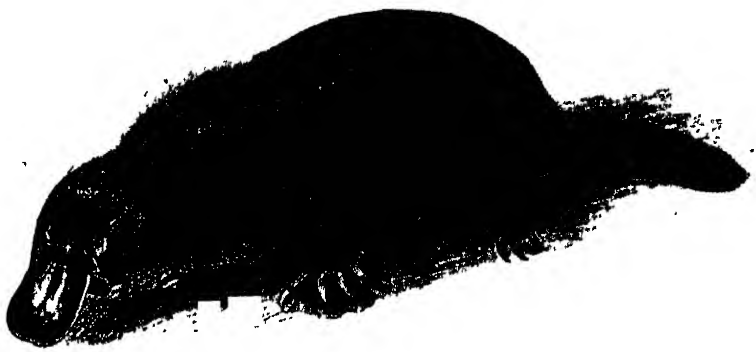

FIG. 55.—Duck-billed Platypus. *Ornithorhynchus anatinus*. × ⅓.

for a considerable portion of the animal's life, and are only shed, like milk teeth, "after being worn down by friction with food and sand." We have already (p. 98) called attention to the general similarity of these teeth to those of certain of the earliest Mammalia and of mammal-like reptiles. The teeth are all molars, and they are either eight or ten in number. They are replaced by the horny plates of the adult animal; but the mode of replacement is curious. The plates are developed from the epithelium of the mouth, but round and under the true teeth; the epithelium of the mouth grows gradually under the calcified teeth, a method of growth which has possibly something to do with the shedding of the latter. The hollows and

[1] *Quart J. Micr. Sci* xxix. 1888, p. 353.

[2] *Proc Roy. Soc.* xlvi. 1889, p. 127. See also Stewart, *Quart. J. Micr. Sci.* xxxii. 1892, p. 229.

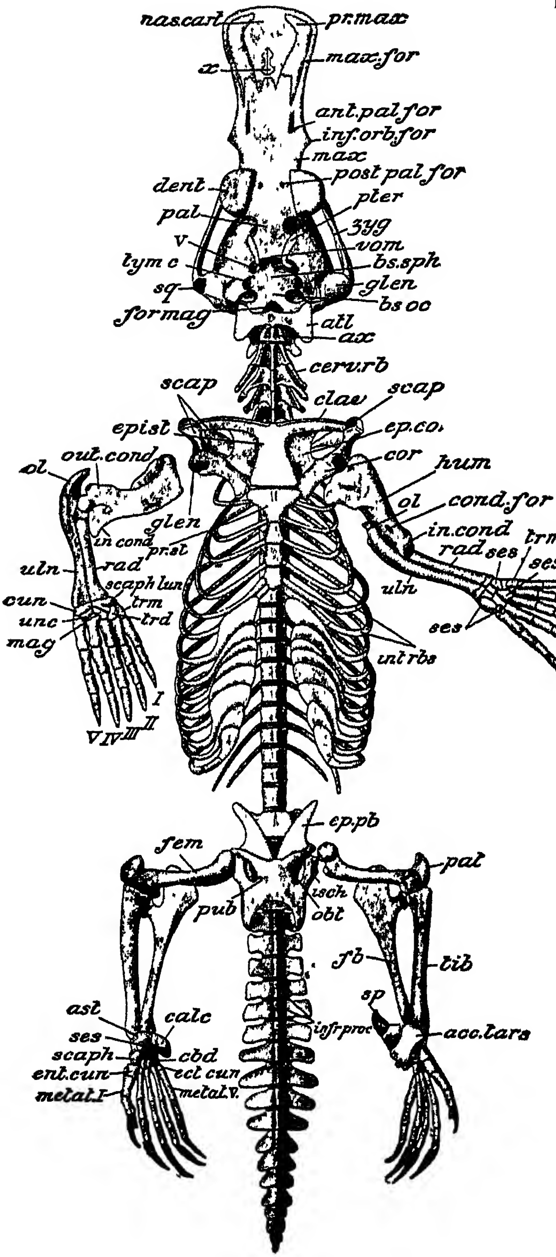

FIG. 56.—Skeleton of male *Ornithorhynchus*. Ventral view. The right fore-limb has been separated and turned round so as to bring into view the dorsal surface of the manus. The lower jaw is removed. *acc tars*, Accessory tarsal bone supporting the spur; *ant.pal.for*, anterior palatine foramen; *ast*, astragalus; *atl*, atlas; *ax*, axis; *bs oc*, basi-occipital; *bs.sph*, basi-sphenoid; *calc*, calcaneum; *cbd*, cuboid; *cerv.rb*, cervical rib; *clav*, clavicle; *cond.for*, foramen above inner condyle of humerus; *cor*, coracoid; *cun*, cuneiform of carpus; *dent*, horny dental plate; *ect.cun*, ecto-cuneiform; *ent.cun*, ento-cuneiform; *ep.co*, epicoracoid; *epist*, episternum; *ep.pb*, epipubis; *fb*, fibula; *fem*, femur; *for.mag*, foramen magnum; *glen*, glenoid cavity of shoulder-joint; *glen*, glenoid cavity for mandible; *hum*, humerus; *in.cond*, inner condyle of humerus; *inf.orb.for*, points to position of infra-orbital foramen; *infr.proc*, inferior processes of caudal vertebrae; *int.rbs*, intermediate ribs; *isch*, ischium; *mag*, magnum of carpus; *max*, maxilla; *max.for*, maxillary foramen; *metat.I*, first metatarsal; *metat.V*, fifth metatarsal; *nas.cart*, nasal cartilage; *obt*, obturator foramen; *ol*, olecranon; *out.cond*, outer condyle of humerus; *pal*, palatine; *pat*, patella; *post.pal.for*, posterior palatine foramen; *pr.max*, premaxilla; *pr.st*, presternum; *pter*, pterygoid; *pub*, pubis; *rad*, radius; *scap*, scapula; *scaph*, scaphoid of tarsus; *scaph.lun*, scapho-lunar; *ses*, sesamoid bones of wrist and ankle; *sp*, tarsal horny spur; *sq*, squamosal; *tib*, tibia; *trd*, trapezoid; *trm*, trapezium; *tym.c*, tympanic cavity; *uln*, ulna; *unc*, unciform; *vom*, vomer; *x*, dumb-bell shaped bone; *zyg*, zygomatic arch; *I-V*, digits of manus; *V*, foramen for fifth nerve. (From Parker's *Zoology*.)

grooves in the plates are the remains of the original alveoli of the teeth

The Duck-billed Platypus is, as every one knows, an aquatic animal. It is not found all over Australia, but is limited to the southern and eastern parts of that continent, and to Tasmania. The animal excavates a burrow for itself in the bank of the slow streams which it frequents. The burrow has one opening below the water and one above; and it is of some length, twenty to fifty feet. The Platypus feeds upon animal food, chiefly "grubs, worms, snails, and, most of all, mussels." These it stows away when captured into its capacious cheek-pouches. The food is then chewed and swallowed above the surface as the animal drifts slowly along. Dr. Semon, from whose work, *In the Australian Bush*, this account of the animal's habits is quoted, thinks that in the nature of the food of the creature the explanation of the loss of the teeth is to be found. He is of opinion that for cracking the hard shells of the mollusc *Corbicula nepeanensis*, upon which *Ornithorhynchus* mainly feeds, the horny plates are preferable to brittle teeth. *Ornithorhynchus* is apparently not eaten by the natives by reason of its ancient and fish-like smell. Besides, it is hard to catch on account of its diving capacities, which are aided by an acute sense of sight and of hearing. When the Duck-bill was first brought to this country it was believed to be a deliberate fraud, analogous to the mermaids produced by neatly stitching together the fore-part of a monkey and the tail of a salmon.

CHAPTER VI

INTRODUCTION TO THE SUB-CLASS EUTHERIA

Sub-Class II.—EUTHERIA

Definition.—Mammalia with teats. Mammary glands of sebaceous type. Heart with entirely membranous and complete right auriculo-ventricular valve. Brain generally with a corpus callosum. Coracoid much reduced and not reaching sternum. No interclavicle. Vertebrae with epiphyses. Ribs double-headed. Viviparous, with a small ovum.

In this group are included not only the Eutheria in the sense of Huxley, but also his Metatheria. Though the Metatheria, or Marsupials as we shall term them, undoubtedly form a most distinct order of mammals, perhaps even a trifle more distinct than most others, their differences from the remaining tribes are not by any means so great as those which separate *Ornithorhynchus* and *Echidna* from all other mammals. In his well-known memoir upon the arrangement of the Mammalia,[1] Professor Huxley enumerated eleven characters as distinguishing the Metatheria either from the Prototheria or from the Eutheria. Of these only three were characters in which they approach the lower mammals According to his showing, therefore, the preponderance of marsupial features are Eutherian. The three characters of Prototherian type are (1) the presence of epipubes; (2) the small corpus callosum; (3) the absence of an allantoic placenta.

The last of these can be dismissed, in consequence of the recent discovery of an allantoic placenta in *Perameles*. The first character is apparently a valid distinction between the Marsupials

[1] *Proc. Zool. Soc.* 1880, p. 649.

and their mammalian relatives higher in the series; but it is not a character that should have been made use of by Huxley, since he believed in the existence of a corresponding element in the Dog. As to the corpus callosum (Fig. 50, p. 77) being small, that seems to be not more than a slight difference of degree.[1] A number of other characters of secondary importance were added by Huxley to the weight of evidence which led him to form a group Metatheria for the Marsupials. Some of these, however, are now known to be not evidence in that direction. For instance he observed that no Marsupial had more than a single successional tooth. It seems at the present moment to be fairly clear that Marsupials have a milk dentition like other Eutherians, but that only one of these teeth, the fourth premolar, comes to functional maturity. That it is really one of a complete milk series is evidenced by the fact that this tooth is differentiated contemporaneously with another series formerly held to belong to the so-called prelacteal dentition.[2] There still remains, of course, the actual fact that

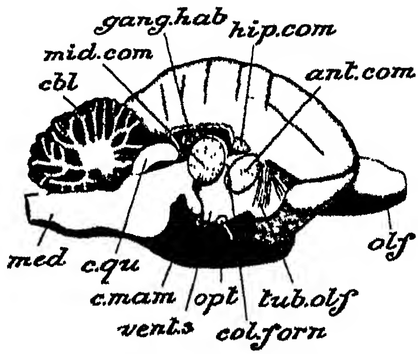

FIG. 57. - Brain of *Echidna aculeata*; sagittal section. *ant.com*, Anterior commissure; *cbl*, cerebellum; *c.mam*, corpus mammillare; *col.forn*, column of the fornix; *c.qu*, corpora quadrigemina; *gang.hab*, ganglion habenulare; *hip.com*, hippocampal commissure; *med*, medulla oblongata; *mid.com*, middle commissure; *olf*, olfactory lobe; *opt*, optic chiasma; *tub.olf*, tuberculum olfactorium; *vent.* 3, third ventricle. (From Parker and Haswell's *Zoology*.)

the milk dentition is not for the most part functional, but its significance breaks down with these fresh discoveries. Of this Professor Osborn has remarked: "The discovery of the complete double series seems to have removed the last straw from the theory of the marsupial ancestry of the Placentals." But Huxley did not lay much stress upon this matter of the teeth, since he observed that similar suppressions of the milk dentition were to be found in many other mammals admittedly Eutherian.

Huxley regarded the peculiarities in the reproductive organs

[1] Moreover, the "corpus callosum and the anterior commissure . . in . . . *Erinaceus* and *Dasypus* are almost Monotreme-like."

[2] See Wilson and Hill, *Quart. J. Micr. Sci.* xxxix. 1896, p. 427.

of the Marsupials as "singularly specialised characters," in no way intermediate in character. This view applies also to the pouch, which, as already stated, distinguishes the adults of that group. But the impossibility of using this last character as one of any importance has been shown by the discovery of rudiments of it in embryos of undoubtedly Eutherian mammals (see p. 18).

Less stress is laid now upon the existence of four molars in the Marsupials as dividing them from the higher mammals than was formerly the case. The total dentition of the group is on the whole composed of more numerous individual teeth than in the typical Eutheria; but we have exceptions like the Whales, the Armadillo *Priodontes*, and the Manatee; or better, because free from the suspicion of secondary multiplication, *Otocyon* and occasionally (according to Mr. Thomas) *Centetes*. In the last two there are at least sometimes four molars.

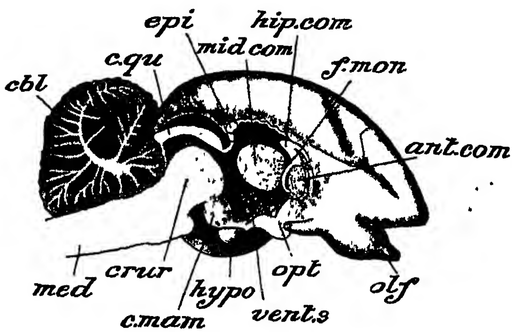

FIG. 58.—Sagittal section of brain of Rock Wallaby (*Petrogale penicillata*). *ant.com*, Anterior commissure; *cbl*, cerebellum; *c.mam*, corpus mammillare, *c.qu*, corpora quadrigemina; *crur*, crura cerebri, *epi*, epiphysis, with the posterior commissure immediately behind it; *f.mon*, position of foramen of Monro, *hip.com*, hippocampal commissure, consisting here of two layers continuous behind at the spleneum, somewhat divergent in front where the septum lucidum extends between them; *hypo*, hypophysis; *med*, medulla oblongata; *mid.com*, middle commissure, *olf*, olfactory lobe; *opt*, optic chiasma; *vent.* 3, third ventricle. (From Parker and Haswell's *Zoology*.)

On the other hand, a few archaic characters of some importance crop up here and there among the Marsupials, which are sometimes held to point to a primitive ancestry. It has been remarked that in Marsupials it is the fourth toe which is dominant in size, whereas in Ungulates it is the third. An attempt has been made to explain this on the view (reasonable enough in itself) of a tree-living ancestry for the group. A greater development of the fourth toe is, however, by no means a necessary character of arboreal creatures; the Primates themselves are an exception. Nor is this prevalence universal among the Marsupials;

in *Myrmecobius* (alone) is the third toe the longest; and no great difference can be detected between the third and fourth toes in the case of the genera *Phascologale, Didelphys,* and some others. Professor Leche compares the predominance of the fourth toe with the hyperphalangeal condition in the fourth toe of the embryo Crocodile, and considers it an archaic feature, not surpassed by the ancient characteristics of the Monotremata. Again it has been pointed out that in *Phascologale* and *Perameles,* the epistropheus (axis vertebra) has a separate rib as in *Ornithorhynchus* In the third place, the likeness of the teeth of *Myrmecobius* to those of *Ornithorhynchus* is an argument in the same direction, which is furthermore supported by the great age (Mesozoic) of the Metatherian group, if we are right in regarding those extinct creatures as Marsupials.

We may now mention certain facts which are not so generally used. The partly primitive structure of the right auriculo-ventricular valve in the Monotremata has no counterpart in any Marsupial which has been dissected; but there are traces in the latter of the characteristic "ventral mesentery" of *Ornithorhynchus* and *Echidna*.[1] Mr. Caldwell's interesting observation upon the segmenting egg of the Marsupial, the incompleteness of the first segmentation furrow (reminding us of the meroblastic ovum of the Monotreme), may possibly not turn out to be so exclusively Marsupial a feature as has been thought.

The balance of evidence thus points to the nearer relationship of the Marsupials to the Eutherian mammals; and their great specialisation combined with certain evidences of degeneration (disappearance in part of the milk dentition), and their age, point to the fact that they are, at any rate, the descendants of an early form of Eutherian. But they must have separated from the Eutherian stock after it had acquired a definite diphyodonty and the allantoic placenta, the two principal features of the Eutherian as opposed to the Prototherian mammals.

Nevertheless it seems probable that the Marsupial tribe is derived from some of the earliest Eutherians. And on this view may be explained the retention of Prototherian characters.

The remaining Eutheria are obviously all to be referred to one great division with the possible exception of the Whales, whose affinities form one of the principal difficulties to the student

[1] In *Dendrolagus* at any rate. See *Proc. Zool. Soc.* 1895, p. 132.

of this group. A short résumé of what is at present thought of the systematic position of this anomalous order is appropriate here. Albrecht went so far as to regard the Cetacea as the nearest group of animals to the hypothetical Promammalia.[1] But discounting his arguments by the removal of such of them as relate to structure plainly altered by the singular mode of life of these creatures, there is really a great deal to be said in favour of his view.

The chief facts which argue a primitive position among mammals for the Cetacea are perhaps: (1) the slight union of the rami of the lower jaw; (2) the occasionally rather marked traces of the double constitution of the sternum; (3) the long and simple lungs; (4) the retention of the testes within the body-cavity; (5) the occasional presence (in *Balaenoptera*) of a separate supra-angular bone. These points, however, are but few, and are not of such great weight as those which ought to be present to establish a claim to separate treatment for the Cetacea as opposed to the Eutheria. If this group of mammals can be tacked on anywhere, it appears to us that the nearest relatives are not, as is sometimes put forward, the Ungulata or the Carnivora, but the Edentata. There are quite a number of rather striking features in which a likeness is shown between these apparently diverse orders of mammals. The chief ones are these: (1) the existence of traces of a hard exoskeleton, of which vestiges remain in the Porpoise; (2) the double articulation of the rib of the Balaenopterids to the sternum, with which compare the conditions obtaining in the Great Anteater; (3) the concrescence of some of the cervical vertebrae; (4) the share which the pterygoids may take in the formation of the hard palate; (5) the fact that in the Porpoise, at any rate, as in many Edentates, the vena cava, instead of increasing in size as it approaches the liver, diminishes.

Another group which is perfectly isolated is that of the Sirenia. The alliance advocated by some with the Cetacea, and quite recently renewed by Professor Haeckel, is contradicted by so many important features that it seems necessary to abandon it. The recent discovery of a fossil Sirenian jaw by Dr. Lydekker with teeth highly suggestive of those of Artiodactyla, may prove a clue. A third group which is so isolated as to have been placed in a

[1] *Anat. Anz.* i. 1886, p. 338; and see Weber, *ibid.* ii. 1887, p. 42

primary division, proposed to be called Paratheria, is that of the Edentates. Probably the group so called should really be divided into the Edentata and the Effodientia, the latter containing the Old World forms. Whether or not it be ultimately shown that the Ganodonta are ancestral Edentates (*sensu strictiori*), the connexion of the group with others is not at present plain. The same is the case with the extensive order of Rodents. It is true that the extinct order of the Tillodontia shows certain Rodent-like characters on the one hand, and likenesses to Ungulates on the other. Certain likenesses shown by such apparently diverse animals as the Rabbit and the Elephant used to be insisted upon by Professor Huxley. For the present, however, the Rodents must remain as an isolated group with only very dubious affinities to others. The remaining groups of existing mammals are easier to connect. At first the differences between a Cat and a Horse seem to be quite as wide as those which separate any two of the higher Eutherian orders. But it seems to become clearer and clearer, as palaeontological investigation proceeds, that the bulk of the Ungulate and the Carnivorous, Insectivorous, and perhaps Lemuroid stocks converge into the early Eocene Creodonta. From the Lemuroid branch the higher Primates can be derived. The only "Ungulates" which cannot be fitted in with some reasonable probability is the group of the Proboscidea. But of the early forms of this division we have at present no knowledge.

CHAPTER VII

EUTHERIA—MARSUPIALIA

Order I. MARSUPIALIA[1]

THE Marsupials may be thus defined:—Terrestrial, arboreal, or burrowing (rarely aquatic) mammals, with furry integuments; palate generally somewhat imperfectly ossified; jugal bone reaching as far as the glenoid cavity; angle of lower jaw nearly always inflected. The clavicle is developed. Arising from the pubes are well developed and ossified epipubic bones. Fourth toe usually the most pronounced. Teeth often exceed the typical Eutherian number of forty-four, molars generally four on each side of each jaw. As a rule but one tooth of the milk set is functional, which is (according to many) the fourth premolar. Teats lying within a pouch, in which the young are placed. Young born in an imperfect condition, and showing certain larval characters. There is a shallow cloaca. The testes are extra-abdominal, but hang in front of the penis. In the brain the cerebellum is completely exposed; the hemispheres are furrowed, but the corpus callosum is rudimentary. An allantoic placenta is rarely present.

Structurally the Marsupials are somewhat intermediate between the Prototheria and the more typical Eutheria, with a greater resemblance to the latter.

The name Marsupial indicates what is perhaps the most salient character of this order. The pouch in which the young are carried is almost universally present. It is less developed

[1] Works dealing exclusively with the Marsupials are: Lydekker, in Allen's *Naturalists' Library*, 1894; Aflalo, *Natural History of Australia*, Macmillan and Co. 1896; Waterhouse, *Natural History of Mammalia*, i. London, 1848; Oldfield Thomas, *British Museum Catalogue of Marsupialia and Monotremata*, 1888.

on the whole in the Polyprotodont forms, such as the Thylacine, Dasyures, etc., but is found in so many of them that the two divisions of the Marsupials, the Diprotodonts and the Polyprotodonts, cannot be raised to distinct orders on this and other grounds. The marsupial pouch of the Marsupials must not, as has been already pointed out, be confounded with the pouch of the

FIG. 59.—Rock Wallaby (*Petrogale xanthopus*), with young in pouch. × ¼. (After Vogt and Specht.)

Monotreme mammals Distinct teats are found in the marsupium of the Marsupials, while there are none in the mammary pouch of the Monotreme, the pouch itself indeed representing an undifferentiated teat, of which the walls have not closed up. The pouch opens forward in the Kangaroos, and backwards in the Phalangers and in the Polyprotodonts. Its walls are supported by a pair of bones diverging from each other in a V-shaped manner; these are cartilaginous and vestigial in the Thylacine. They

are the precise equivalents of similar bones in the Monotremata. It has been held, but apparently erroneously, that these bones are mere ossifications in the tendons of the external oblique muscle of the abdomen, or of the pyramidalis of the same region; and vestiges have been asserted to exist in the Dog. Such bonelets are undoubtedly present in the Dog; but it seems clear from their development in Marsupials, as structures actually continuous with the median unossified portion of the symphysis pubis, that the "marsupial bones" belong to that part of the skeleton, and that they correspond with the epipubis of certain amphibians and reptiles. The pouch, it may be remarked, exists in a rudimentary form in the males of many Marsupials.

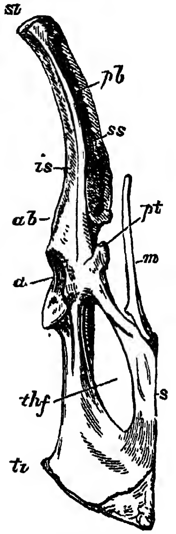

FIG. 60.—Ventral surface of innominate bone of Kangaroo (*Macropus major*). × ⅓. *a*, Acetabulum; *ab*, acetabular border of ilium; *is*, iliac surface; *m*, "marsupial" bone; *pb*, pubic border, *pt*, pectineal tubercle; *s*, symphysis; *si*, supra-iliac border; *ss*, sacral surface; *thf*, thyroid foramen; *ti*, tuberosity of ischium. (From Flower's *Osteology*.)

The most salient feature in the life-history of the Marsupials is the imperfect condition in which the young are born. The egg is no longer laid, as in the Monotremes; but curiously enough, the ovum, which has the small size of that of the Eutheria, divides incompletely at the first division (as Mr. Caldwell has shown), and this developmental feature may perhaps be looked upon as a reminiscence of a former large-yolked condition. The young when born are small and nude; the newly born young of a large Kangaroo is perhaps as large as the little finger. The young are transferred by the lips of the mother to the pouch, where they are placed upon a teat. It is an interesting fact that they are not merely imperfect foetuses, but that they are actual larvae. They possess in fact at any rate one larval organ in the shape of

FIG. 61.—Mammary foetus of Kangaroo attached to the teat. (Nat. size.) (From Parker and Haswell's *Zoology*.)

a special sucking mouth. This sucking mouth is an extra-uterine production, and is of course an adaptation to the particular needs of the young, just as are other larval organs, such as the chin-suckers of the tadpole, or the regular ciliated bands of the larvae of various marine invertebrate organisms.

There are a number of other features which distinguish the Marsupials from other mammals.

The cloaca of the Marsupials is somewhat reduced, but is still recognisable. Its margins in *Tarsipes* are even raised into a wall, which projects from the body.

The tooth series of the Marsupials was once held to consist of one dentition only, with the exception of the last premolar, which has a forerunner. The interpretation of the teeth of Marsupials are various. Perhaps most authorities regard the teeth as being of the milk dentition, with the exception of course of the single tooth that has an obvious forerunner. But there are some who hold that the teeth are of the permanent dentition. In any case it is proved that a set of rudimentary teeth are developed before those which persist. Those who believe in the persisting milk dentition describe these as prelacteal. Another matter of importance about the teeth of this order of mammals is that their numbers are sometimes in excess of the typical Eutherian 44. This, however, holds good of the Polyprotodonts only.

It was for a long time held that the Marsupials differed from all other mammals in having no allantoic placenta. But quite recently this supposed difference has been proved to be not universal by the discovery in *Perameles* of a true allantoic placenta. The Marsupials have been sometimes called the Didelphia. This is on account of the fact that the uterus and the vagina are double. Very frequently the two uteri fuse above, and from the point of junction an unpaired descending passage is formed (see Fig. 48 on p. 74).

A character of the brain of Marsupials has been the subject of some controversy. Sir Richard Owen stated many years ago that they were to be distinguished from the higher mammals by the absence of the corpus callosum. Later still it was urged that a true corpus callosum, though a small one, was present; while, finally, Professor Symington[1] seems to have shown that

[1] "The Cerebral Commissures in the Marsupialia and Monotremata," *Journ. Anat. Phys.* xxvii. 1893, p. 69.

the original statement of Owen was correct, at least in part. It is at most feebly developed (see Fig. 58, p. 118).

As to skeletal characters, the Marsupial skull has on the whole a tendency towards a permanent separation of bones usually firmly ankylosed. Thus the orbitosphenoids remain distinct from the presphenoid. The palate is largely fenestrated, a return as it were—says Professor Parker—to the Schizognathous palate of the bird. The mandible is inflected; this familiar character of the Marsupials goes back to the earliest representatives of the order in Mesozoic times (see p. 96); but it is not absolutely universal, being absent from the much weakened skull of *Tarsipes*. On the other hand, the inflection is nearly as great in certain Insectivores, in *Otocyon*, etc. The malar always extends back to form part of the glenoid cavity. The shoulder girdle has lost the large coracoid of Monotremes; this bone has the vestigial character that it possesses in other Eutheria. The clavicle is present except in the Peramelidae. A third trochanter upon the femur seems to be never present.

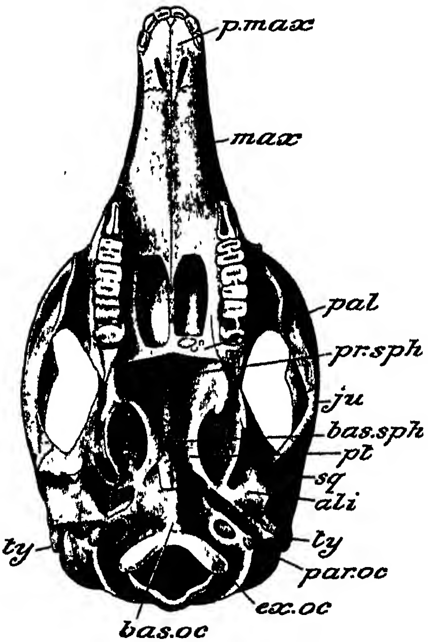

Fig. 62. —Skull of Rock Wallaby (*Petrogale penicillata*). (Ventral view.) *ali*, Alisphenoid; *bas.oc*, basi-occipital; *bas.sph*, basi-sphenoid; *ex.oc*, ex-occipital; *ju*, jugal; *max*, maxilla; *pal*, palatine; *par.oc*, paroccipital; *p.max*, premaxilla; *pr sph*, presphenoid; *pt*, pterygoid; *sq*, squamosal; *ty*, tympanic. (From Parker and Haswell's *Zoology*.)

The Marsupials cannot be regarded as an intermediate stage in the origin of the Eutheria for a number of reasons. In the first place, the nature of their teeth shows them to be degenerate animals; one set, whether we regard it as the milk or permanent dentition, has become vestigial. The recent discovery of a true allantoic placenta in *Perameles* removes one reason for regarding

the Marsupials as primitive creatures. It implies on the whole that the Marsupials have sprung from a stock with an allantoic placenta. The alternative is to assume the independent development of an allantoic placenta in both groups of the Mammalia; unless indeed the genus *Perameles* is to be held to be the most primitive race of Marsupials living, a hypothesis which does not appear on the face of it likely. So long as it was believed that the mammary pouch of the Monotremes was the equivalent of the marsupium of the Marsupials, the persistence of this structure seemed to be a bond of union between the groups. But it is now known that the marsupium is a special organ confined to the Marsupials, an argument which is rather in favour of their being a lateral development of the mammalian stem. It is to be remarked also that the marsupium is feeblest in the Polyprotodonts, which may perhaps be looked upon as the most primitive of the Marsupials, owing to their more numerous teeth and other points to be referred to immediately.

Not only are the Marsupials interesting from the point of view of their structure, their present and past distribution is of equal interest. During the Mesozoic epoch they occurred in Europe and North America; but not, so far as negative evidence means anything, in Australia, which is now their headquarters. In Europe Marsupials lingered on into the Tertiary period, when they finally became extinct. In America, of course, the group has persisted to the present day. Now it is important to notice that the two main subdivisions of the Marsupials, the Polyprotodontia and the Diprotodontia, exist to-day in both Australia and South America. These two divisions, it should be explained, differ principally in that one has numerous, the other rarely more than two,[1] incisors in the lower jaw. It is perhaps the more widely distributed opinion that the Polyprotodontia are the more archaic group; this opinion rests upon one or two facts in addition to the absence of specialisation in the incisor teeth. Among the Polyprotodontia the total number of teeth is greater—a clearly primitive character; secondly, the general form of the body of these animals, with four subequal limbs and carnivorous or omnivorous diet, contrasts with the purely vegetarian and much specialised Kangaroos at any rate. Finally—and sufficient stress

[1] When there are more than two, *two* are especially developed. See Figs. 76, 77 (pp. 149, 150).

has perhaps not been laid upon this matter—the brain among the Polyprotodonts is less convoluted than among the genera of the other division. This statement is of course made with due regard to parallelism in size (see p. 77). It is well known that the complexity of a brain bears a distinct relation to the size of its possessor within the group. Now the most ancient Marsupials are decidedly more Polyprotodont-like. No European form from the earlier periods is distinctly to be referred to the Diprotodonts. But both divisions now exist in America and Australia.

We must assume, therefore, one of three hypotheses. Either the differentiation into the two great divisions occurred in Jurassic or Cretaceous times before the migration of the order southwards; or the Diprotodont type is only a type, and not a natural group, *i.e.* it has been separately evolved in America and Australia; or, finally, there was formerly a land-connexion in the Antarctic hemisphere, along which the Diprotodonts of Australia wandered into South America. The middle hypothesis has this to commend it, that syndactylism occurs in both divisions, and that in some Diprotodonts the pouch opens backwards as it does in the Polyprotodonts. So great are the resemblances that but little difference is really left —of great importance that is to say. Hence it is not difficult to imagine the reduction of the incisors having taken place twice. In favour of the first hypothesis there are no positive facts. Finally, in favour of the last, which is so strongly supported by the facts of distribution derived from the study of other groups of animals,[1] there is at least this striking fact or rather series of facts: that some of the South American fossil Polyprotodonts have a "strictly Dasyurine relationship."[2] If there has not been a direct migration, then the Dasyurine type has been twice evolved, an improbability that few will attempt to explain away. In any case we shall adopt here the usual division of the Marsupials into Diprotodontia and Polyprotodontia.

Sub-Order 1. DIPROTODONTIA.

This group includes the herbivorous Marsupials. The incisors are as a rule three above, but one only in the Wombats. Below

[1] See for a further discussion of this subject the zoögeographical handbooks of Mr. Lydekker and myself, quoted on p. 78 (footnote).

[2] To this may be added Mr. Thomas' observation that the family of American Opossums is "very closely allied to the Dasyuridae, from which, were it not for its isolated geographical position, it would be very doubtfully separable."

is one strong pair, with occasionally one or two rudimentary incisors.

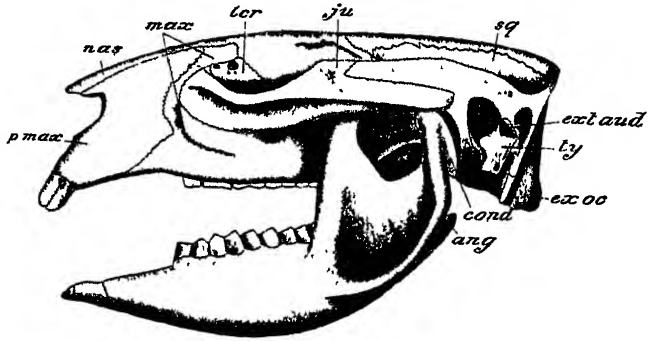

FIG. 63.—Skull of Wombat (*Phascolomys wombat*). (Lateral view.) *ang*, Angular process; *cond*, condyle of mandible; *ext.aud*, opening of bony auditory meatus; *ex.oc*, exoccipital; *ju*, jugal; *lcr*, lachrymal; *max*, maxilla; *nas*, nasal; *p max*, premaxilla; *sq*, squamosal; *ty*, tympanic. (From Parker and Haswell's *Zoology*.)

The upper canines, if present, are not large. The molars are tuberculate or ridged. All Marsupials (except the Wombats) to some extent, and the Macropods especially, are characterised by the prolongation of the tubes of the dentine into the clear enamel. The significance of this fact is, however, lessened by the fact that the same penetration of the enamel by dentinal tubes occurs in the Jerboa, the Hyrax, and some Shrews. The feet have two syndactylous toes,[1] less marked in the Wombats than in the Kangaroos and Phalangers.

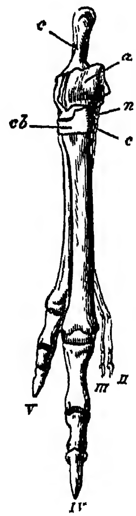

FIG. 64.—Bones of right foot of Kangaroo (*Macropus bennetti*). *a*, Astragalus; *c*, calcaneum, *cb*, cuboid; *c*³, ento-cuneiform; *n*, navicular; *II-V*, second to fifth toes. (From Flower's *Osteology*)

This order is mainly Australian at the present day, using the term of course in the "regional" sense (see p. 84); the only exception indeed to this statement is the occurrence of the genus *Caenolestes* in South America. But it is now known that Diprotodont Marsupials formerly existed in the same part of the world.

Fam. 1. Macropodidae.—This family contains the Kangaroos, Wallabies, Rat-Kangaroos, and Tree-Kangaroos. With the exception of *Dendro-*

[1] Except in the South American Diprotodonts.

lagus the family is terrestrial, and its numerous species progress by leaps effected by the long hind-limbs, which are

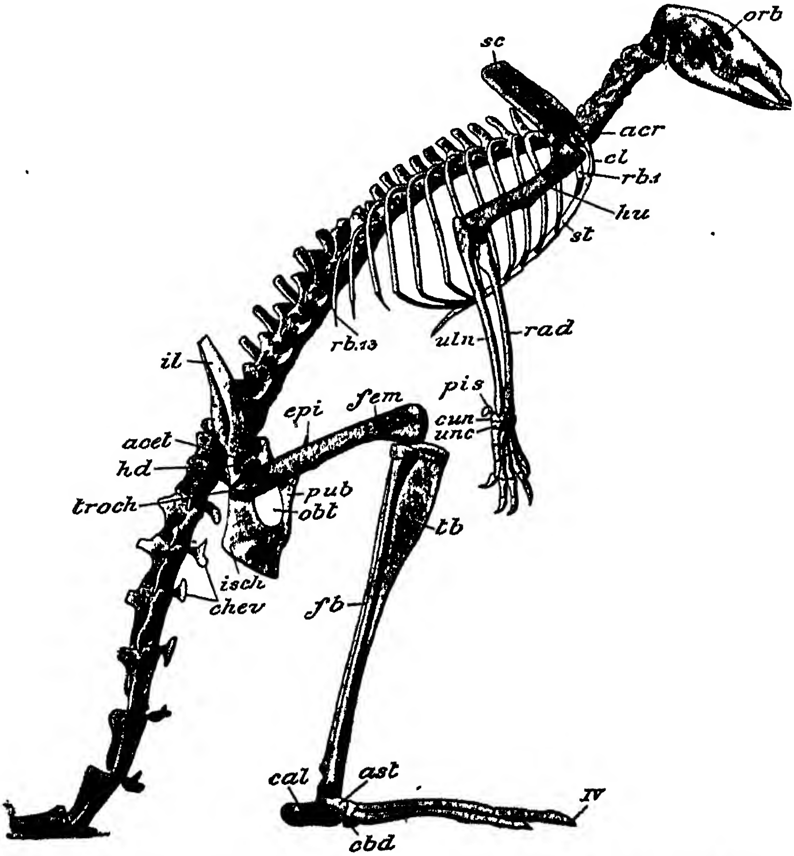

FIG. 65.—Skeleton of Wallaby (*Macropus ualabatus*). The scapula is raised somewhat higher than in nature. The end of the tail is omitted. The head of the femur has been separated from the acetabulum. *acet*, Acetabulum; *acr*, acromion process; *ast*, astragalus; *cal*, calcaneum; *cbd*, cuboid; *chev*, chevron-bones; *cl*, clavicle; *cun*, cuneiform of carpus; *epi*, epipubis; *fb*, fibula; *fem*, femur; *hd*, head of femur; *hu*, humerus; *il*, ilium; *isch*, ischium; *obt*, obturator-foramen; *orb*, orbit; *pis*, pisiform; *pub*, pubis; *rad*, radius; *rb*[1], first rib; *rb*[13], last rib; *sc*, scapula; *st*, sternum; *tb*, tibia; *troch*, great trochanter of femur; *uln*, ulna; *unc*, unciform; *IV*, fourth toe. (From Parker and Haswell's *Zoology*.)

decidedly, often greatly, longer than the fore-limbs. In the hind-limb the fourth toe is very long and strong; the fifth moderately so; the second and third are slender and united by skin. The tail is always long, but differs in its characters from

genus to genus. The stomach is much sacculated. The dental formula is I $\frac{3}{1}$ C $\frac{1 \text{ or } 0}{0}$ P $\frac{2}{2}$ M $\frac{4}{4}$. The atlas is often open below, forming thus an incomplete ring.

Though the number of the incisor teeth in the adult Diprotodonts is never more than three on each side in each jaw, more numerous rudiments are present. Mr. M. Woodward[1] has lately investigated the subject with interesting results. He finds that many species present decided traces of two additional incisors, raising the total to that which characterises the Polyprotodontia; but in two cases, viz. *Macropus giganteus* and *Petrogale penicillata,* a sixth is present, the total number being thus in excess of that found in any other Marsupial. This, as the author himself admits, proves too much No mammal is known which in the adult condition has so many incisors; nor do the fossil Mammalia help us to get over the difficulty; even among reptiles it is not usual for so many teeth to occur upon the premaxillaries.

It is a curious fact that the two long lower incisors can be used after the fashion of a pair of scissors, or rather a pair of shears. Their inner edges are sharpened, and they are capable of some motion towards and away from each other; by their means grass is cropped.

The stomach of *Macropus* (and of other allied genera) is peculiar by reason of its long and sacculated character; the oesophagus enters it very near the cardiac end, which is bifid. Messrs. Schäfer and Williams[2] have shown that the squamous, non-glandular epithelium of the oesophagus extends over the greater part of the stomach, only the pyloric extremity and one of the two cardiac caeca being lined with columnar epithelium.

The Macropodidae are clearly divisible into three sub-families, which are distinguished by marked anatomical characters.

In the sub-family MACROPODINAE (including the genera *Macropus, Petrogale, Lagorchestes, Dorcopsis, Dendrolagus, Onychogale,* and *Lagostrophus*) there is no hallux, and the tail is hairy. The oesophagus enters the stomach near the cardiac end. The caecum when short has no longitudinal bands; the liver has a Spigelian lobe.

The second sub-family, POTOROINAE or HYPSIPRYMNINAE (including the genera *Potorous, Aepyprymnus, Bettongia,* and *Calo-*

[1] *Proc. Zool. Soc.* 1893, p. 450. [2] *Ibid.* 1876, p. 165.

prymnus), consists of smaller animals than the Macropodinae, which, however, resemble them in having no hallux, but a hairy tail. The oesophagus enters the stomach near the pyloric end of that organ. The caecum, though short, has lateral longitudinal bands. The liver has no special Spigelian lobe. The canines are always present, being rarely so in Macropodinae, and are usually well developed

The third sub-family, that of the HYPSIPRYMNODONTIDAE, is doubtfully referable to the family; it consists of but one genus *Hypsiprymnodon*, which is in many points more like a Phalanger than a Kangaroo. It has an opposable hallux and a non-hairy, but scaly, tail. It has canines in the upper jaw.

Sub-Fam. 1. Macropodinae.—The genus *Macropus* includes not only the Kangaroos but also the Wallabies, which are really

FIG. 66.—Red Kangaroo. *Macropus rufus*. × $\frac{1}{18}$.

indistinguishable, though they have sometimes been placed in a separate genus *Halmaturus*. The genus thus enlarged contains twenty-three species. It may be thus characterised: the ears are long, the rhinarium is usually naked, but in *M. giganteus* and others a band of hairs descends to the upper lip; a naked band extends from the ankle to the pads on the digits, which is interrupted in *M. rufus* by a band of hairs just in front of the digits. The mammae are four. The tail is not bushy,

but is crested in *M. irma.* They are for the most part found on the Australian continent, but some species are found in the islands to the north which belong to the Australian region. Thus *M. brunii*, which is of interest as the first Kangaroo seen by a European, is a native of the Aru islands. A specimen of this animal, which was then living in the garden of the Dutch governor of Batavia, was described by Bruyn in the year 1711. *M. rufus*, the largest member of the group, is remarkable for the red secretion which adorns the neck of the male. It is caused by particles which have the appearance and colour of carmine. *M. giganteus* is not, as its specific name might imply, the "giant" of the race; its dimensions are given as 5 feet, while *M. rufus* is said to attain a length of 5 feet 5 inches, exclusive (in both cases) of the tail.

The account which Sir Joseph Banks gives[1] in his diary of the Kangaroo is interesting, since he was one of the first naturalists to see that creature. In July 1770 it was reported to him that an "animal as large as a greyhound, of a mouse colour, and very swift" had been seen by his people. A little later he was surprised to observe that the animal "went only upon two legs, making vast bounds just as the jerboa does." The second lieutenant killed one of these Kangaroos, of which Sir Joseph Banks wrote that "to compare it to any European animal would be impossible, as it has not the least resemblance to any one I have seen. Its fore-limbs are extremely short and of no use to it in walking; its hind, again, as disproportionately long; with these it hops seven or eight feet at a time, in the same manner as the jerboa, to which animal indeed it bears much resemblance, except in size, this being in weight 38 lbs., and the jerboa no larger than a common rat." The beast was killed and eaten, and proved excellent meat. Sir Joseph Banks' observations upon the leaping of the Kangaroo are of interest, because it is often asserted that the tail is largely made use of as a third foot or as a support. Mr. Aflalo declares in the most positive way that after repeatedly examining the tracks upon soft sand immediately after the animal had passed, not the very faintest trace of the impression of the tail could be discovered. The leaps of a big Kangaroo seem to be somewhat greater than is recorded

[1] *Journal of the Rt. Hon. Sir Joseph Banks, Bart., K.B., P.R.S.*, edited by Sir Joseph Hooker, London, 1896.

by Banks. It is said that 15 or even 20 feet are covered at a bound, and in bound after bound. But in walking slowly it can be readily seen from an inspection of Kangaroos at the Zoological Society's Gardens that the animal does rest upon its tail, which with the hind-legs forms a tripod.

Petrogale with six species comes next to *Macropus*, and is indeed only to be differentiated from it by the thickly-haired and more slender tail, which is not used, as it is sometimes in the Kangaroos, as an extra hind-limb. The Rock-Kangaroos live among rocks, which they climb, and from which they leap; and the tail acts rather as a balancing pole. The most elaborate account of the anatomy of *Petrogale* known to me is by Mr. Parsons.[1] The dentition as given by Mr. Thomas is I $\frac{3}{1}$ C $\frac{0}{0}$ Pm $\frac{2}{2}$ M $\frac{4}{4}$—that of *Macropus* without the occasionally occurring canine of the upper jaw. The osteological characters which separate it from *Macropus* are quite insignificant. Mr. Parsons mentions a wormian bone, "os epilepticum," at the junction of the coronal and sagittal sutures. It was found to occur in two out of five skulls examined, and appears not to occur in other Kangaroos. The palatine foramina of *Petrogale* are so large that the posterior part of the bone is only a narrow thickened ridge. The small intestine of *P. xanthopus* is 102 inches long, the large intestine 44 inches. The caecum has a length of 6 inches, and is not sacculated, differing in this from the caecum of *Macropus major*. The best known species are *P. xanthopus* and *P. penicillata*. The genus is confined to Australia itself, and does not enter Tasmania.

Onychogale includes the so-called "Nail-tailed Wallabies," which have a thorn at the end of the tail, reminding one of the Lion and the Leopard, whose tails have a similar armature. The muffle is hairy. Three species are allowed by Mr. Thomas.

Lagorchestes has, like the last genus, the rhinarium, *i.e.* that part of the nose immediately surrounding the nostrils, hairy instead of smooth as in the Kangaroos proper. It is distinguished from *Onychogale* by the absence of the terminal callosity to the tail, which is rather short. The name Hare-Kangaroo is given to the members of this genus (three species) on account of their exceeding fleetness. This genus is limited to Australia itself. *L. conspicillatus* is said to present "a remarkable resem-

[1] *Proc. Zool. Soc.* 1896, p. 683.

blance to the English hare," and *L. leporoides* was so called by Gould on account of general appearance as well as face.

Dorcopsis has shorter hind-legs than *Macropus*, and a naked muffle. The ears are small. The structure of *D. luctuosa* has been studied by Garrod,[1] who pointed out the existence of four enlarged hair follicles on the neck near the mandibular symphysis. These are, however, represented in the next genus *Dendrolagus*, and occur also in *Petrogale*. The limbs are not so disproportionate as in *Macropus*, and the tail is naked at the tip.

Dorcopsis and the next genus to be described, *Dendrolagus*, differ from *Macropus* and its immediate allies, *Petrogale* and *Lagorchestes*, in a number of anatomical points. In the first place, the premolars are twice the size of those of *Macropus*, and they have a characteristic pattern not observable in the Kangaroos. This consists of a median ridge (the whole tooth being rather prismatic in shape), with lateral ridges at right angles to it. The upper canines are developed, but are minute.

The stomach is not quite like that of *Macropus*, though built upon a similar plan. The blind cardiac extremity is a single, not a double cul-de-sac; in this it is like that of *Petrogale*. The distribution of the squamous, white, oesophageal epithelium is very much like that of *Dendrolagus*. In both genera the orifice of the oesophagus into the stomach is guarded by two strong longitudinal folds, which run for some distance towards the pylorus. In *Dendrolagus*, at any rate, this tract is bordered on each side by glandular patches. In *Dendrolagus*, moreover, the squamous epithelium does not extend into the cardiac cul-de-sac. This latter is separated from the rest of the stomach by two slightly diverging folds, which are faintly represented in *Petrogale* and in *Halmaturus*. In the last two genera the folds surrounding the oesophageal orifice are but slightly represented; better in *Halmaturus* than in *Petrogale*. But there are not the patches of glands already referred to. The small intestine of *Dorcopsis* is 97 inches in length, the large being 32, *i.e.* proportionately long, as in Marsupials generally. The small caecum ($2\frac{1}{2}$ inches) is not sacculated.

The spleen is Macropodine, being T-shaped or Y-shaped. The differences between *Dorcopsis* and the evidently closely allied *Dendrolagus* will be further considered under the description of

[1] *Proc. Zool. Soc.* 1875, p. 48.

the latter. *Dorcopsis* is confined to New Guinea, and contains three species, viz. *D. muelleri, D. luctuosa,* and *D. macleani.* *D. muelleri* has a striking resemblance to *Macropus brunii,* with which it has been confounded. Though intermediate between *Macropus* and *Dendrolagus,* these Kangaroos are not arboreal.

The genus *Dendrolagus* is remarkable for its un-kangaroo-like habit of living in trees. In accordance with this change of habit is a relative shortening of the hind-limbs, a feature which

FIG. 67 —Tree-Kangaroo. *Dendrolagus bennetti.* × $\frac{1}{12}$.

begins to be observable in *Dorcopsis.* "The general build," writes Mr. Thomas, "is of the ordinary mammalian proportions, not macropodiform at all" The muffle is not naked for the greater part, though the shortness of the hairs gives that effect. As in *Dorcopsis,* but not as in *Macropus,* the bulla tympani is not swollen. There are altogether five species, the fifth, *D. bennetti,* having been lately described from specimens living in the Zoological Society's Gardens.

The anatomy of this genus has been described by Owen for *D. inustus,*[1] and by myself for *D. bennetti* The stomach, which

[1] *Proc. Zool. Soc.* 1852, p 103.

has a single, not bifid, cul-de-sac, is sacculated by two principal bands and other subsidiary ones. Its internal structure has already been to some extent described. The spleen of *D. bennetti* is remarkable for the fact that it is not T-shaped, whereas *D. inustus* agrees with other Macropodines in the form of this organ. The small intestine of *D. bennetti* is 95 inches long, the large 38. The caecum appears to differ in the two species, it is smaller in *D. bennetti,* where it is only 2 inches in length. The most remarkable feature of the liver is the large size of the left lateral lobe and the bilobed condition of the Spigelian lobe; this at least was the case with *D. bennetti.* A recently-described species [1] has been attentively studied in its native haunts by Dr. Lumholtz.[2] It lives in the highest parts of the mountainous scrubs of Queensland, where it moves quickly on the ground as well as among the trees. It is hunted with Dingos by the "blacks," and is eaten by them.[3]

Lagostrophus is a generic name that has been proposed by Mr. Thomas for a small Wallaby 18 inches in length, which is distinguished by the fact that the long claws of the hind-limbs are entirely hidden by long and bristly hairs; the muffle is naked; there is no canine. The bullae are swollen. There is but one species of the genus, *L fasciatus,* a native of West Australia.

Sub-Fam. 2. Potoroinae.—*Aepyprymnus* and the other genera placed in this sub-family are known by the vernacular name of Rat-Kangaroos, or sometimes Kangaroo-Rats. The latter term has been called "incorrect," though it is just as good as the former, both of them in fact being inaccurate as implying some likeness to or relation with a Rat. The present genus has a partially hairy rhinarium; the auditory bullae are not swollen. It contains but one species, *Ae. rufescens,* a native of Eastern Australia, which is distinguished by its very long hind-feet.

Bettongia has long hind-feet as in *Aepyprymnus,* but the rhinarium is entirely naked instead of being partially hairy, while the ears are much shorter. The genus, which contains four species, is remarkable as being the only ground-living mammal with a prehensile tail, which it uses to carry grass, etc.

1 *Proc. Zool Soc* 1895, p. 131.
2 *Ibid.* 1884, p 387.
3 *Ibid.* 1884, p. 407

B. lesueuri burrows in the ground, often to so great a depth as 10 feet The genus occurs in Tasmania as well as in Australia.

Caloprymnus, with one species, is a genus instituted by Mr. Thomas in his Catalogue of Marsupials for a form (*C. campestris*) which combines in a remarkable way the characters of *Aepyprymnus*, *Bettongia*, and *Potorous*. The external characters and the general shape of the skull are as in *Bettongia*, while the molars have the structure of those of *Aepyprymnus*. The last premolar is as in *Potorous*.

Of the genus *Potorous* there are three species, which are Tasmanian as well as Australian. Unlike the other Rat-Kangaroos, the hind-feet are comparatively short, and the animal is therefore less addicted to jumping than its relatives. The rhinarium is naked, and the ears are of fair length.

Sub-Fam. 3. Hypsiprymnodontinae.—The Musk-Kangaroo, *Hypsiprymnodon*, is the last genus of the present family, and the only genus of this sub-family. It is intermediate between the Macropodidae and the Phalangeridae, the annectant character being mainly the hind-feet, which though they have the same long fourth digit as the Kangaroos, have it more feebly developed, and possess also an opposable hallux, which is one of the salient features in the structure of the Phalangeridae. The tail is naked and scaly; the rhinarium is entirely naked. The ears are large and not furry. The single species, *H. moschatus*, appears to feed upon insects as well as vegetables.

"Its habits are chiefly diurnal, and its actions when not disturbed by no means ungraceful. It progresses in much the same manner as the Kangaroo-Rats (*Potorous*), to which it is closely allied, but procures its food by turning over the débris in the scrubs in search of insects, worms, and tuberous roots, frequently eating the palm berries, which it holds in its fore-paws after the manner of the Phalangers, sitting up on its haunches, or sometimes digging like the bandicoots." This is Mr. Ramsay's description of the animal, which he was the first to discover.[1]

Fam. 2. Phalangeridae.—The genus *Hypsiprymnodon* bridges over the not very wide gap which separates the Kangaroos from the Phalangers. The Phalangers are Marsupials with five fingers and toes; the second and third toes are bound together by a

[1] *Proc. Linn. Soc. N.S. Wales*, i 1877, p. 34.

common integument as in the Macropodidae. The hallux is opposable and nailless. The tail is nearly always long and prehensile. The pouch is well developed; the stomach not sacculated; a caecum is present (except in *Tarsipes*). These are really the principal distinctions between the two families. In addition, it may be mentioned that the lower incisors have not a scissor-like action as in the Kangaroos.

The Phalangers may be divided into four sub-families.

The first of these, that of the PHALANGERINAE, contains the genera *Phalanger* (including *Cuscus*), *Acrobates*, *Distaechurus*, *Dromicia*, *Gymnobelideus*, *Petaurus*, *Petauroides*, *Dactylopsila*, *Pseudochirus*, and *Trichosurus*.

These genera agree in the following generalities:—Tail well developed, often very long; three incisors above, and at least two premolars both above and below; caecum long and simple; stomach without a cardiac gland; liver not very complicated by secondary furrows, with a distinct caudate lobe; the vaginal median culs-de-sac often coalesced, lungs with an azygos lobe.

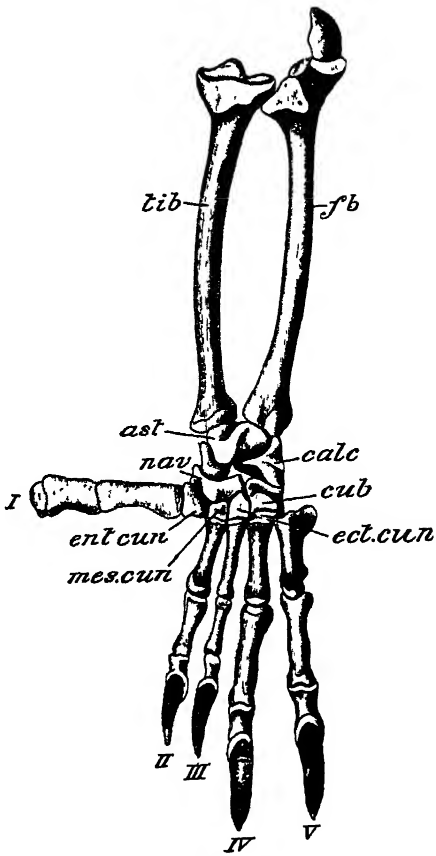

FIG. 68.—Bones of leg and foot of Phalanger. *ast*, Astragalus; *calc*, calcaneum; *cub*, cuboid, *ect.cun*, ecto-cuneiform; *ent.cun*, ento-cuneiform; *fb*, fibula; *mes.cun*, meso-cuneiform; *nav*, navicular; *tib*, tibia; *I-V*, first to fifth toes. (After Owen.)

The second sub-family, PHASCOLARCTINAE (with the Koala only), is thus characterised:—Tail rudimentary; cheek-pouches present, superior incisors three, but only one premolar above and below,

caecum extraordinarily long; stomach with a cardiac gland, liver complicated by additional furrows, without a free caudate lobe, no azygos lobe to lungs, vaginal culs-de-sac free.

The third sub-family, PHASCOLOMYINAE, contrasts with the others as follows:—Tail rudimentary; cheek-pouches present, but rudimentary; one incisor on each side above, but no additional premolars; all the teeth rootless; caecum not peculiar in shape, stomach with a cardiac gland: liver complicated by secondary furrows, without a free caudate lobe; lung with an azygos lobe, vaginal culs-de-sac free.

The last sub-family, TARSIPEDINAE, is thus defined:—Tail long; tongue extensile; only one premolar; molars reduced caecum absent.

Sub-Fam. 1. Phalangerinae.—The genus *Phalanger* embraces five species, sometimes called by the generic name of *Cuscus*. They

FIG. 69 —Vulpine Phalanger. *Trichosurus vulpecula.* $\times \frac{1}{8}$.

are largish animals with short ears; only the end of the tail is naked. Of these animals only one species is found in Australia itself, the rest inhabiting the islands lying to the north. The Spotted Cuscus, *Ph. maculatus,* is in spite of its vegetarian diet, and perhaps on account of its spots, spoken of as the "Tiger Cat." Mr. Aflalo remarks of it that though provided with a prehensile tail, it is little better as a climber than the tailless Koala.

Trichosurus, including the "True Phalangers," includes largish species, which can be distinguished from the last genus by a chest-gland similar to that which occurs in *Myrmecobius* and some other Marsupials of the present group. There are but two species, which are purely Australian. The "Brush-tailed Opossum," *T. vulpecula* (perhaps better known as *Phalangista*

vulpina), like its American pseudo-namesake (a true Opossum, genus *Didelphys*), "plays 'possum" on occasions. The dental formula is I $\frac{3}{2}$ C $\frac{1}{0}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$. The ears are shortish.

The Ring-tailed Phalangers, *Pseudochirus*, are more widely distributed than the last two genera; they range from Tasmania in the south to New Guinea in the north. They are not, however, ring-tailed, though the tip of the tail is generally white. As in the last genera, which have prehensile tails, the end of this appendage is naked. The mammae are four. The tooth formula is I $\frac{3}{2}$ C $\frac{1}{0}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$. There are some ten species of the genus.

The Striped Phalanger, *Dactylopsila trivirgata*, is an animal about a foot long, whose identity can be ascertained by its striped, black and white skin. It is an arboreal creature that lives apparently both on leaves and grubs like so many arboreal creatures of quite different groups Squirrels, for instance, and New-World Monkeys. The tooth formula is I $\frac{3}{3}$ C $\frac{1}{0}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$.

Gymnobelideus leadbeateri is a small creature with a body 6 inches in length. It is restricted to the colony of Victoria. The general look is that of *Petaurus*; the ears are naked.

Dromicia is a genus of Phalangers which although devoid of a parachute, such as is possessed by certain genera that will be considered immediately, is able to leap with great agility from branch to branch. The ears are large and thin and almost naked; the tooth formula is I $\frac{3}{2}$ C $\frac{1}{0}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$. They are minute creatures, the longest measuring, with the tail, but 10 inches. Dormouse-Phalanger is a name sometimes given to them. There are four species, ranging from Tasmania to New Guinea. The name Dormouse as applied to the genus seems to be owing to the way in which they hold a nut in the paws when feeding. *D. nana* is 4 inches long, with a tail of nearly the same length. It is thick at the base.

Distaechurus is the last genus of non-flying Phalangers. Its name refers to the arrangement of the hairs on the tail, which are disposed on either side in a row like the vane of a feather. The tooth formula is I $\frac{3}{2}$ C $\frac{1}{0}$ Pm $\frac{3}{3}$ M $\frac{3}{3}$, very nearly as in *Acrobates*. The ears are as in that genus.

Petaurus is the first genus of the Flying Phalangers, all of which are provided with a parachute-like expansion of the skin between the fore- and hind-limbs; the ears are large and naked: and the tooth formula is I $\frac{3}{2}$ C $\frac{1}{0}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$. There are three

species of the genus, which extend through pretty well the entire Australian region. The term "flying" as applied to these and the other "flying" genera is of course an exaggeration. The animals cannot fly upwards; they can only descend in a skimming fashion, the folds of skin breaking their fall. *P. breviceps* is perhaps the best-known species. The body is 8, the tail 9 inches long.

Petauroides seems to be chiefly distinguished from *Petaurus* by the fact that, as in its ally *Dactylopsila*, the tail is partly naked terminally. In *Petaurus* and *Gymnobelideus* the tail is bushy to the very end, including its extreme tip below.

A third genus of Flying Phalangers is the minute *Acrobates*, which has a distichous tail like that of *Distaechurus*. It is not more than 6 inches in length including the tail. As to these Flying Phalangers it is exceedingly instructive to observe that the same method of "flight" has been apparently evolved three times; for the three genera are each of them specially related to a separate type of non-flying Phalanger. The same observation can be made about the Flying Squirrels, *Anomalurus* and *Sciuropterus*. The dental formula is I $\frac{3}{2}$ C $\frac{1}{0}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$. The ears are thinly clad with hair. There are four teats.

Sub-Fam. 2. Phascolarctinae.—The Koala, or Native Bear, *Phascolarctos cinereus*, is the only representative of its sub-family. It is, like the Wombat, aberrant in the lack of an obvious tail. The absence of this appendage is curious in an arboreal creature whose near allies have a long and prehensile one. The structure of the Koala was investigated by the late Mr. W. A. Forbes.[1] There are some unexpected points of likeness to the Wombat: thus they agree in the absence of the tail, in the structure of the stomach, and in the great subdivision of the lobes of the liver. The brain, however, is smooth, and the caecum is exceedingly large and complicated in structure, that of the Wombat being short. That both animals have cheek-pouches is perhaps due to similar habits of temporarily storing masses of food. This animal has only eleven pairs of ribs. The tail has only seven or eight vertebra, and these have no chevron-bones.

A peculiarity of the skull is seen in the great size of the alisphenoid bulla, which is comparable in size and appearance with that of the Pig. As in the Kangaroos, the atlas is incomplete below.

[1] "On some Points in the Anatomy of the Koala," *Proc. Zool. Soc.* 1881, p. 180.

The tooth formula of the genus is $I\,\frac{3}{1}\,C\,\frac{1}{0}\,Pm\,\frac{1}{1}\,M\,\frac{4}{4 \text{ or } 5}$. The additional lower molar seems to be exceptional, and has been found in one specimen only.

In the alimentary tract the most remarkable structure is the large intestine, which is very capacious for the first 28 inches or so of its course. This section of the colon is lined with rugae precisely like those which are found in the caecum. These folds, which at first are some twelve in number, fuse lower down, and by the time that the colon approaches the external orifice are reduced to five. Similar folds, as already stated, occur in the caecum, but do not extend as far as its blind end. The caecum is proportionately and actually larger than in any other Marsupial. The gall-bladder is unusually elongated.

The Koala is mainly crepuscular or nocturnal in its habits. It feeds so exclusively upon the leaves of the gum-tree (*Eucalyptus*)

FIG. 70.—Koala. *Phascolarctos cinereus.* $\times \frac{1}{6}$.

that it is impossible to keep the creature long in captivity in lands where that particular kind of food is not available.

The female, though she seems to bear but a single young one, which is carried on the back after the fashion of some Opossums, has two nipples. The animal's slow habits seem to require a nocturnal and retired life. It is about as lethargic as the Sloth, and it is said to further resemble that animal in clinging firmly to a branch even after it is shot.

Sub-Fam. 3. Phascolomyinae.—*Phascolomys*, the Wombat, is the only genus of this sub-family. This animal has the appearance of a heavily-built Marmot, like which it has a mere stump for a tail, and a pair of strong chisel-shaped and Rodent-like incisors, which, however, differ from those of Rodents in having a complete coating of cement. All the teeth of the animal are rootless, and there are no canines. The incisors have enamel on the front and lateral faces only. The dental formula is $I\,\frac{1}{1}\,C\,\frac{0}{0}\,Pm\,\frac{1}{1}\,M\,\frac{4}{4}$. The affinities with other Diprotodont Marsupials are shown by the commencing syndactyly of the second and third toes. The

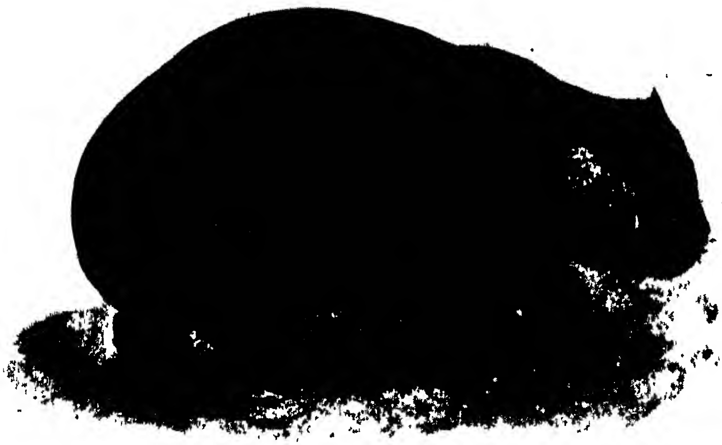

FIG. 71.—Wombat. *Phascolomys wombat.*

rhinarium is naked or hairy. There is a rudimentary cheek-pouch, as in *Phascolarctos*. The Wombat has, like the Koala, and also the Beaver—which does away with some of the value of the comparison—a peculiar gland-patch in the stomach, a raised area of collected glands. In no other Marsupial is such a structure found, "whilst in the two forms under consideration its identity is almost precise. That such a unique structure should have been independently developed in two forms unrelated to each other, appears to me to be in the highest degree improbable." This is Mr. Forbes' opinion. It might be strengthened by adding the observation, that, as there are other points of likeness between the Wombat and the Koala, it seems more unlikely that a structure so nearly identical should have been twice

developed in two not very distant forms. As in the Kangaroos, the atlas is open below. *Ph. ursinus* has 15 ribs; the other species the normal (for Marsupials) 13. Other points of likeness will be mentioned under the description of the Koala. These animals

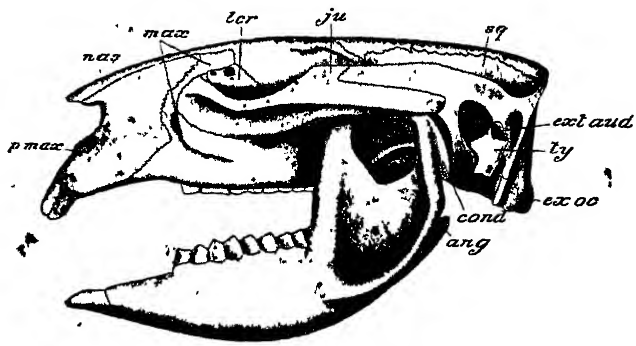

FIG. 72.—Skull of Wombat. *Phascolomys wombat.* (Lateral view.) *ang*, Angular process; *cond*, condyle of mandible; *ex.oc*, exoccipital; *ext.aud*, opening of bony auditory meatus, *ju*, jugal; *lcr*, lachrymal; *max*, maxilla; *nas*, nasal, *p.max*, premaxilla, *sq*, squamosal; *ty*, tympanic. (From Parker and Haswell's *Zoology*.)

mainly feed upon roots; they live in companies in burrows. There are three species—*Ph. ursinus*, *Ph. latifrons*, and *Ph. mitchelli*. *Ph ursinus* is Tasmanian in range, the other two species South Australian.

Sub-Fam. 4. Tarsipedinae.—The genus *Tarsipes* ought perhaps to be removed from the present family. There is but a single species, which is a small creature of 7 inches in total length, of which the tail measures 4 inches The teeth are much dwindled, the formula being I $\frac{2}{1}$ C $\frac{1}{0}$ Pm $\frac{1}{0}$ M $\frac{3}{3}$ = 22. The lower incisors are procumbent. The lower jaw, moreover, has not the characteristic Marsupial inflection. The intestinal canal is without the caecum present in the remaining Phalangeridae. It is a curious fact that this aberrant little Phalanger should come from Western Australia, like the even more aberrant *Myrmecobius*. Like the latter also, *Tarsipes* has a long exsertile tongue, with which, however, it extracts honey from flowers. Probably it also catches minute insects in the corollas of the flowers. It has been proved, in fact, that in captivity at any rate the animal is insectivorous, for it has been known to eat moths.

Fam. 3. Epanorthidae—The extinct Epanorthidae of Pata-

gonia are represented to-day by a small Marsupial which has been rediscovered within the last two or three years. This little animal, formerly called *Hyracodon* (a pre-occupied name), is now termed *Caenolestes*, and is a native of Colombia and Ecuador. There are two species, and of these *C. obscurus* is called by the inhabitants "Raton runcho," which means opossum-rat. It lives apparently upon bird's eggs and small birds, though it belongs to the Diprotodont division of the Marsupials. *Caenolestes*, however, although diprotodont, has not the syndactylous character of the digits of the feet already referred to in the Kangaroos and their allies. The pouch is small and rudimentary. The dentition is $I \frac{4}{3}\ C \frac{1}{1}\ Pm \frac{3}{3}\ M \frac{4}{4} = 46$, and the teeth are said by Mr. Thomas to be much like those of the Australian *Dromicia*.[1]

In the skull a peculiarity which does not bear upon its affinities to other Marsupials, but is still interesting, is mentioned by Mr. Thomas. The nasals are not sufficiently prolonged to meet the upper edge of the maxillae, and so a vacuity is left, as in the skulls of many Ruminants (*e.g.* the Sable Antelope). The palate is very imperfect; the foramina, which render it so, reach as far forward as the last premolar. The lower jaw has quite the appearance of that of a *Macropus* or *Phalanger*, with long and forwardly projecting incisors.

Extinct Diprotodonts.—The great *Diprotodon* is a creature with a skull a yard long, which must have been of the size of a large Rhinoceros. Though closely allied to *Macropus*, it seems that this great beast did not hop after the fashion of a Kangaroo, its limbs being of a more equal size than in the Kangaroo. Recently some further remains of *Diprotodon* have been discovered in a lake known as Lake Mulligan, where they had apparently been bogged. Professor Stirling has contributed an account of these remains, which fills up a considerable gap in our knowledge. He has been able to state the structure of the fore- and hind-limbs. Both limbs are pentadactyle, the fingers of the fore-limb being approximately equal in length and general development. In the hind-limb the hallux is small, and consists of the metatarsal only. This bone is fixed in the position of "extreme abduction," and is suggestive of an arboreal limb. Digits two and three may have

[1] Thomas, "On *Caenolestes*, a still existing survivor of the Epanorthidae of Ameghino, and the representative of a new family of recent Marsupials," *P.Z.S.* 1895, p. 870.

been syndactylous, and the authors of the account[1] of these bones think that the fourth toe may have shared in this syndactyly. The metatarsal of the fifth digit is enormously expanded at its

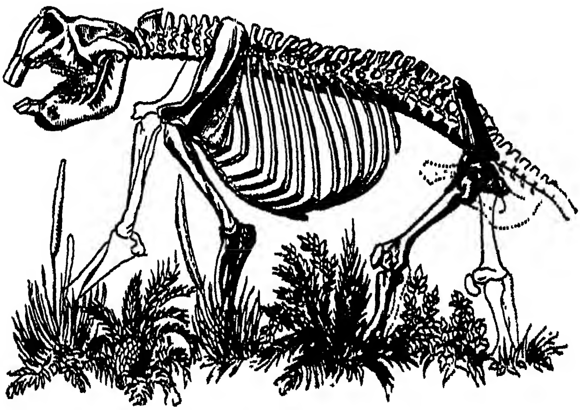

FIG. 73.—*Diprotodon australis.* (After Owen.)

edge, and seems to have furnished a strong support to the creature; this is also seen in the metacarpal of the fore-limb. Probably, therefore, *Diprotodon* was quadrupedal in its mode of progression, with the emphasis laid upon the little finger and the little toe instead of, as in ourselves, the first toe The hind-foot of the *Diprotodon* could not be more unlike that of a Kangaroo than it actually is.

FIG. 74.—*Thylacoleo carnifex.* Side view of skull. (After Flower.)

Another giant among these Marsupials was the genus *Thylacoleo*, whose name was given to it by Sir Richard Owen on the view that it was a Marsupial Tiger. Sir W. Flower has, however, controverted this opinion, and the genus is in fact, in spite of its large size, closely allied to the Phalangers and

[1] Stirling and Zietz, *Mem. Roy. Soc. South Australia*, i.; see also a notice in *Nature*, January 18, 1900.

Cuscuses.[1] The dental formula is I $\frac{3}{1}$ C $\frac{1}{0}$ Pm $\frac{3}{1}$ M $\frac{1}{2}$; the last premolar is a great blade-shaped tooth like that of *Potorous*

Nototherium was a creature smaller than *Diprotodon*, but still of large size; it is believed to have been a burrowing creature, and to connect the Wombats with *Diprotodon*. More certainly allied to the existing Wombat was *Phascolonus*, a Wombat as big as a Tapir.

Of extinct American Diprotodonts the Epanorthidae, already referred to in connexion with the living *Caenolestes*, were the most

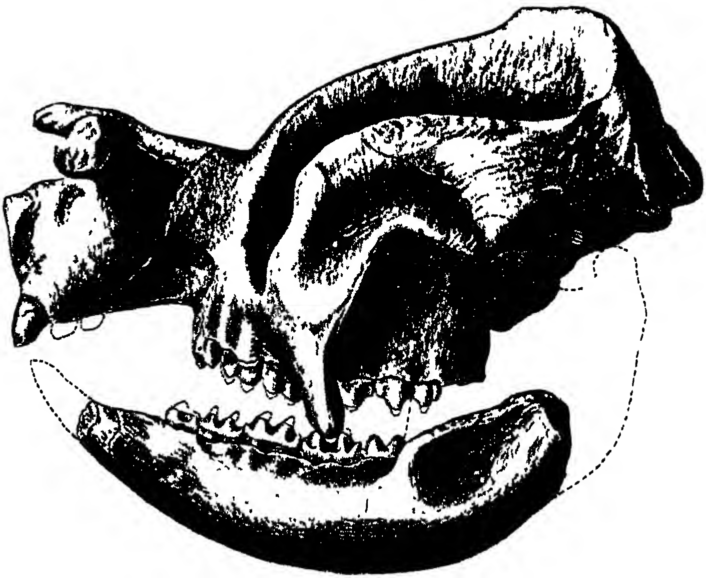

FIG. 75.—*Nototherium mitchelli*. Side view of skull. × ⅛ (After Owen.)

prominent forms. The genus *Epanorthus* occurs in the Santa Cruz formation of Patagonia, which is believed to be Miocene. The incisors are three in the upper jaw; and the single incisor of each ramus of the lower jaw is a great chisel-shaped, cutting instrument.

Abderites is also typically Diprotodont by reason of the large projecting incisors of the lower jaw. It has a large cutting tooth in the lower jaw, which appears to be the last premolar, and is thus comparable to the great cutting tooth of the lower jaw and of the upper jaw of the extinct Phalanger, *Thylacoleo*.

[1] Quite recently (*Proc. Linn. Soc. N.S.W.* 1898, p. 1) the carnivorous character of *Thylacoleo* has been reasserted by Mr. Broom.

It may also be comparable to the great premolar of such Multituberculata as *Ptilodus* and *Plagiaulax*. It is, moreover, marked with vertical grooves.

An interesting form, which is unfortunately but little known is the Australian and Pleistocene genus *Triclis*, with one species, *T. oscillans*. In having a minute canine tooth in the lower jaw it agrees with some Phalangeridae, and being otherwise closely allied to *Hypsiprymnodon*, it unites the Macropodidae with the Phalangeridae.

Sub-Order 2. POLYPROTODONTIA.

In this mainly carnivorous or insectivorous division of the Marsupials the incisors are four or five on each side of the upper

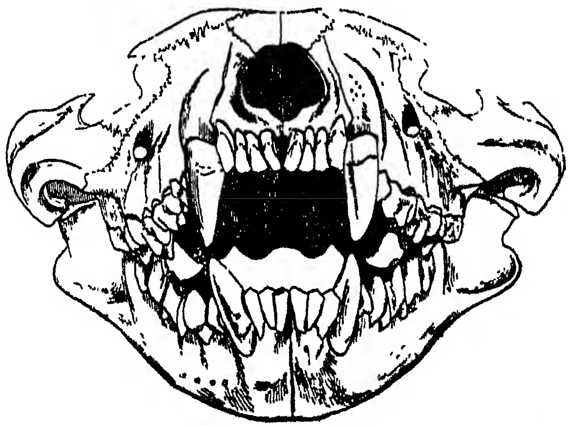

Fig. 76.—Front view of the skull of Tasmanian Devil (*Sarcophilus ursinus*), showing Polyprotodont and carnivorous dentition. (After Flower.)

jaw, and one or two fewer in the lower jaw. Figs. 76 and 77 illustrate the Polyprotodont and Diprotodont dentitions. The canines are those of flesh-eaters and so are the molars, being as a rule sharply cuspidate. As a rule, which has an exception in the Peramelidae, there is no syndactylism of toes in the hind-foot. This sub-order is at the present day Australian and American in its range.

Fam. 1. Dasyuridae.—This family consists of Marsupials which are generally pentadactylous, but with occasionally the hallux missing The tail is long but not prehensile. The pouch is present or absent. The teeth vary in the different genera, but

the upper incisors are never less than three, and may be as many as five in the upper jaw and six in the lower. The canines are trenchant. There is no caecum.

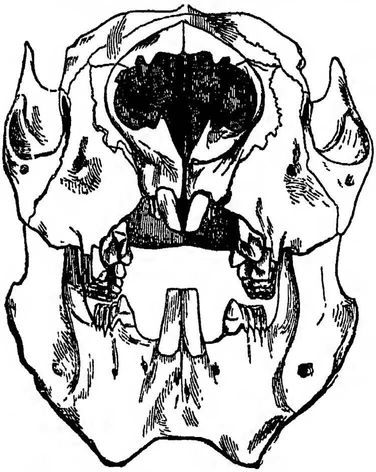

FIG 77.—Front view of skull of Koala (*Phascolarctos cinereus*), illustrating Diprotodont and herbivorous dentition. (From Flower.)

The genus *Thylacinus* contains but a single species, which is now limited to Tasmania, and is generally known as the Tasmanian Wolf. It has the build of an ordinary Wolf, and is of about the same size. The hinder part of the body is marked with a series of black transverse bands. The hallux is entirely wanting; the pouch opens backwards. The marsupial bones are minute and unossified. The dental formula is I $\frac{4}{3}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$ = 46. There

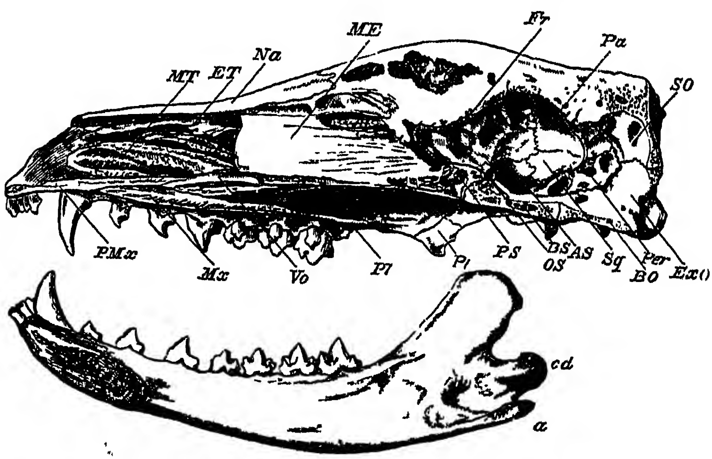

FIG. 78.—Longitudinal section of the skull of the Thylacine (*Thylacinus cynocephalus*). × ½. *a*, Angular process of mandible; *AS*, alisphenoid; *BO*, basioccipital; *BS*, basisphenoid; *cd*, condyle of mandible; *ET*, ethmoturbinal; *Ex. O*, exoccipital; *Fr*, frontal; *ME*, ossified portion of mesethmoid; *MT*, maxilloturbinal; *Mx*, maxilla; *Na*, nasal, *OS*, orbitosphenoid; *Pa*, parietal; *Per*, periotic; *Pl*, palatine; *PMx*, premaxilla; *PS*, presphenoid; *Pt*, pterygoid; *SO*, supraoccipital; *Sq*, squamosal; *Vo*, vomer. (From Flower's *Osteology*.)

are four mammae. This animal, now confined to Tasmania,

is getting rarer on account of its sheep-killing propensities, and the consequent war of extermination declared upon it by the colonists. It will, however, feed upon other animals; and it is related that the first specimen ever captured had in its stomach the remains of an Echidna! Mr. Thomas thinks that the persistence of this and of some of the other larger carnivorous Marsupials in Tasmania after their extinction in Australia is not unconnected with the advent of the Dingo. But it is stated that the Thylacine is quite capable of keeping even a pack of dogs at bay.

The genus *Sarcophilus* has been frequently confounded with the next, but it is kept apart by Mr. Thomas, who follows

FIG. 79.—Tasmanian Devil. *Sarcophilus ursinus.* $\times \frac{1}{10}$.

Cuvier in this. An alternative generic name is *Diabolus*, which, like the first name, refers to the habits and character of the single species which this genus contains. The genus is more like *Thylacinus* than is *Dasyurus*. The hallux is wanting, and the teeth, though fewer in number (42), resemble those of the Thylacine more closely than do those of the Dasyure. The species is called *S. ursinus*, the popular name being Tasmanian Devil. It is black with a variable number of white patches on the body. It is of about the size of a Badger, and is, like the Thylacine, a nocturnal animal. The Tasmanian Devil is said to be one of the most ferocious of animals, and to express its ferocity by a "yelling growl."

The next genus of this family, *Dasyurus*, comprises five species, which range over the whole of the Papuan and Australian sub-regions. The general form is Viverrine, and the hallux is sometimes present though small. The dental formula is as in the

last genus, but the teeth "are more insectivorous in their character." There are six or eight mammae The members of this genus are grey or brown, and spotted with white; they are

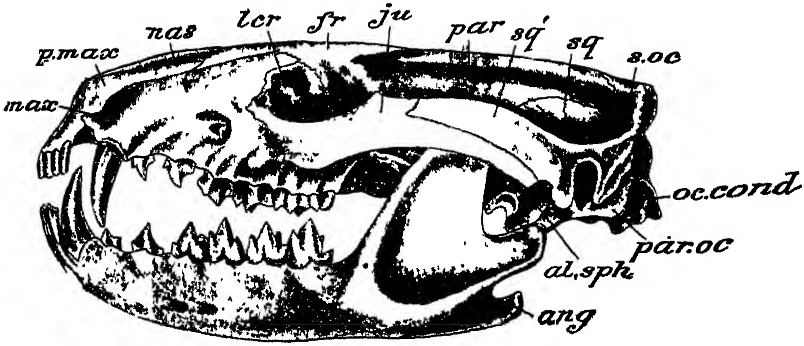

FIG. 80—Skull of *Dasyurus*. (Lateral view.) *al.sph*, Alisphenoid; *ang*, angular process of mandible; *fr*, frontal, *ju*, jugal; *lcr*, lachrymal; *max*, maxilla; *nas*, nasal; *oc.cond*, occipital condyle, *par*, parietal; *par.oc*, paroccipital process; *p.max*, premaxilla; *s.oc*, supraoccipital; *sq*, squamosal; *sq'*, zygomatic process of squamosal. (From Parker and Haswell's *Zoology*.)

all arboreal, and feed largely upon birds and their eggs. Mr. Thomas has pointed out that in two species, *D. viverrinus* and *D. geoffroyi*, the striae upon the foot-pads are absent, and that

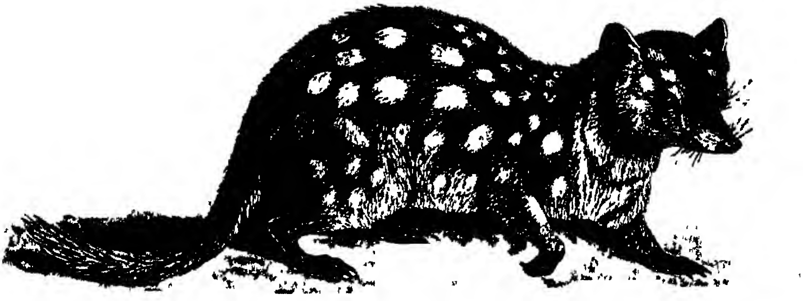

FIG 81.—Dasyure. *Dasyurus viverrinus*. × ⅓. (After Vogt and Specht.)

therefore these at least are probably not so purely arboreal as the rest. The animals are not diurnal, and during the day hide themselves in the hollow trunks of trees. They are spoken of as "Native Cats," but have the general habits of Martens. *D. maculatus* is common in Tasmania, but is rare in Australia, thus "approaching the condition now exhibited by the Thylacine and

Tasmanian Devil, namely, complete extermination in Australia, where both once lived." *D. hallucatus* shows an approach to *Phascologale* in its five-toed hind-feet and slender build.

Phascologale is a genus which, like the last, is usually arboreal (although not *P. virginiae* of North Queensland), but is of much smaller size, the species not exceeding the dimensions of a rat. They have no spots, but there is sometimes a stripe down the back. There are thirteen species, which have the same range as the last genus. The hallux is present though small, but the pouch is "practically obsolete," though there is a small fold of skin behind the teats. The rhinarium is naked; the tail is long, "bushy, crested, or nearly naked." The mammae are four to ten in number. The dental formula is as in *Dasyurus*, and the teeth are not very different in form; sometimes the last premolar is wanting. "The members of this genus," remarks Mr. Thomas, "evidently take the place in the Australian region filled in the Oriental by the Tupaiae, and in the Neotropical by the smaller Opossums."

The genus *Sminthopsis* comprises not more than four species, even smaller than the last The largest species, *S. virginiae*, is only 125 mm. in length. The hallux is present, and there is a well-developed pouch. There are forty-six teeth, as in the Dasyures. The feet are narrow with granulated or hairy soles, whereas in *Phascologale* they are broad with smooth soles. The mammae are eight or ten. The genus ranges through Australia and Tasmania.

The genus *Antechinomys* has but a single species, which is a native of Queensland and New South Wales. The build is Jerboa-like, and the animal is, as might be inferred, terrestrial. The ears are very long, and the limbs elongated; the hallux is absent; the teeth are exactly as in *Sminthopsis*.

Antechinomys has thirteen dorsal and seven lumbar vertebrae; three sacrals and twenty-five caudals, the latter number being in excess of that of its allies. The stomach is nearly globular, with approximated orifices, the intestine measured 6 8 inches, a little more than twice the length of the animal itself. *A. lanigera* is a native of East Central Australia, and appears to be entirely terrestrial in habit, and to progress by a series of leaps—at any rate when going at full speed.

Professor Spencer, who found examples of this rare species, gives

an interesting description of its habits. *Antechinomys* has much the look of the Australian Rat, *Hapalotis mitchelli*, and as the two animals lead a similar kind of life, the resemblance is not unexpected. Professor Spencer wonders why these creatures are saltatory in habit. The country which they inhabit is arid, but with patches of grass and shrubs. For a big kangaroo the advantage of the power of leaping over such obstacles may be obvious, but not for the small and slender *Antechinomys*. The chief foes of this rare Marsupial appear to be predatory birds; and Professor Spencer thinks that the saltatory mode of progression may be more baffling to such pursuers than even a rapid run.

The genus *Dasyuroides* has been lately instituted by Professor Spencer for a Marsupial from Central Australia somewhat intermediate between *Sminthopsis* and *Phascologale*. As there is but one species, the generic will be considered with the specific characters. *D. byrnei* is an animal of about the size of the Common Rat. The hallux is absent. The tail is fairly thick, but not "incrassated." There are six mammae, and the pouch is but slightly developed, with two low lateral folds. The dentition is I $\frac{4}{3}$ C $\frac{1}{1}$ Pm $\frac{3}{2}$ M $\frac{4}{4}$. This Marsupial is nocturnal, and burrowing in habit. Its food consists of insects.[1]

Myrmecobius is so different from the last-described genera (DASYURINAE) that it is usually separated from them as a sub-family MYRMECOBIINAE. The animal is of a bright rufous colour, banded posteriorly with white. There is no hallux, though the metatarsal belonging to that digit is present. There are four mammae.[2] On the chest is a naked patch of some extent, upon which open the ducts of a complex gland, which has been described and figured by myself.[3] There is no pouch, but a tract of skin shows indications of a pouch-like structure. The teeth are extraordinarily numerous, fifty to fifty-four; the formula being I $\frac{4}{3(4)}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{5}{6}$. Their resemblance to those of certain Jurassic Marsupials is dealt with on p. 100.[4] In this matter lies of

[1] *Horn Scientific Expedition*, pt. ii. *Zoology*, 1896, p. 36.

[2] Leche found five, and Waterhouse stated eight to be the number.

[3] *Proc. Zool. Soc.* 1887, p. 527. See also Leche, *Biol. Foren. Förhandl.* 1891, p. 136, and literature quoted.

[4] Traces of horny pads, like those of the Duck-bill, have been asserted to exist in this animal. This is exceedingly interesting when regarded in conjunction with its multituberculate molars.

course the chief interest of the genus, which may be "an unmodified survivor from Mesozoic times, and therefore from a time long before the Didelphyidae, Peramelidae, and Dasyuridae were differentiated one from the other." Another ancient feature

Fig. 82.—Banded Australian Anteater. *Myrmecobius fasciatus.* × $\frac{1}{6}$.

(found in Jurassic mammals) is a mylo-hyoid groove upon the lower jaw, which, however, is not always present, and its existence has therefore been denied. The single species, *M. fasciatus*, is partly arboreal and partly terrestrial in habit, and feeds upon ants. It is a Western and Southern Australian form.

Fam. 2. Didelphyidae.—All the members of this family are pentadactylous. The teeth are fifty in number, arranged thus: I $\frac{5}{4}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$. The caecum is small; the pouch is generally absent; the tail generally long and prehensile.

Fig. 83.—Virginian Opossum. *Didelphys virginiana.* × $\frac{1}{4}$. (After Vogt and Specht.)

The genus *Didelphys* contains most of the forms belonging to this family, including as it does some twenty-three species. The Opossums are mainly arboreal animals, insectivorous in their food; but the larger species eat reptiles, birds, and their eggs. Several of the small species carry their young, when able to leave the teats, on

their back, the tails of the young being wrapped round that of the mother. It is not only the pouched species which carry their young in something of this fashion. Azara's Opossum, an animal as big as a cat, is said to carry its eleven young ones (themselves as large as rats) on the back, though their foothold does not appear to be strengthened by intertwining the tails. Even with this huge family on her back, the mother can climb trees with considerable alacrity. The mammae

FIG 84.—Thick tailed Opossum. *Didelphys crassicaudata.* × $\frac{1}{4}$.

are seven to twenty-five in number. The genus has been lately split up into a number of genera, *Marmosa*, *Dromiciops*, *Peramys*, etc.

Chironectes is hardly different from *Didelphys*. It has webbed hind-feet, and is aquatic in habit. The one species of the genus is known as the Yapock, and is a Central and South American form. It is of about the size of a large rat, and appears to be an expert diver after the fish upon which it lives.

Fam. 3. Peramelidae.—The Bandicoots, although clearly belonging to the Polyprotodont Marsupials, yet agree with the Diprotodonts in the fact that the second and third toes of the feet are bound up in a common integument, which is not the case with the Diprotodont *Caenolestes*. The hind-feet are longer than the front; of the former limb, two or three of the fingers alone are long and functional; the others are rudimentary or absent. Tail long, hairy, and non-prehensile. Dentition I $\frac{5}{3}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{4}{4}$ = 48, or sometimes, owing to the absence of a pair of upper incisors, 46. There is a caecum.

The genus *Peragale*, the Rabbit-Bandicoots, consists of two

species entirely Australian in range. The enormous ears (whence

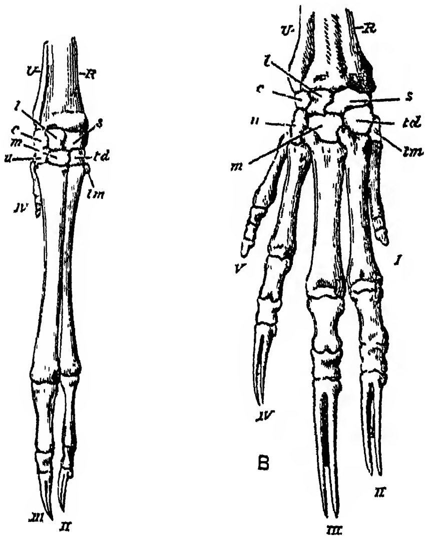

FIG. 85.—Bones of manus. A, of *Choeropus castanotis*. × 2. B, of Bandicoot (*Perameles*). × 1½. *c*, Cuneiform; *l*, lunar; *m*, magnum, *R*, radius; *s*, scaphoid; *td*, trapezoid; *tm*, trapezium; *u*, unciform; *U*, ulna; *I-V*, digits. (From Flower's *Osteology*.)

"Rabbit" Bandicoot) distinguish this genus from *Perameles*.

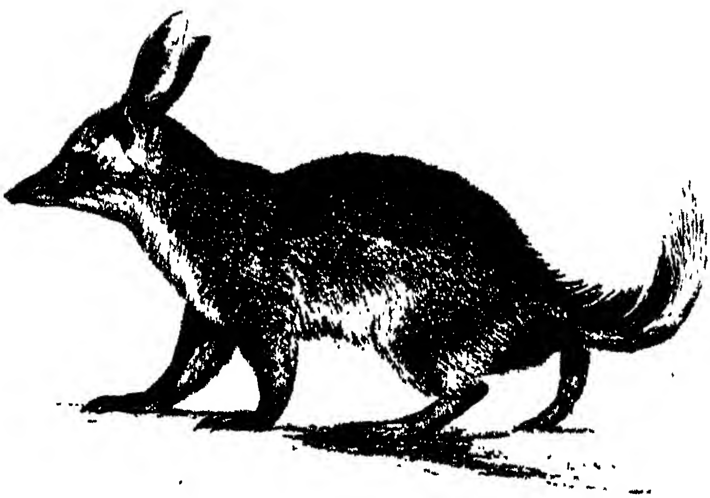

FIG. 86.—Rabbit Bandicoot. *Peragale lagotis*. × ½.

The pouch opens backwards, and there are eight mammae. *P. lagotis*, the only species about whose ways of life anything is

known, burrows in the soil, whence it extracts grubs; it is also a grass-feeder, and it is said that its likeness to a Rabbit in appearance is strengthened by its similarity in flavour!

Perameles is a genus consisting of twelve species, which are found in Tasmania, Australia, and New Guinea. Like the last genus, from which it does not widely differ in other points, *Perameles* consists of species which combine insectivorous and vegetarian habits. One species is said to become in captivity an expert in catching mice. The pouch opens backwards, and there are six or eight mammae.

The last genus of this family is *Choeropus*, containing but one species, *Ch. castanotis*. It is confined to the Australian con-

Fig. 87.—Pig-footed Bandicoot. *Choeropus castanotis.* × ⅓.

tinent. It is to be distinguished from the last two by the fact that there are only two functional digits, the second and third, in the fore-limb; the fourth is rudimentary; the other two are absent. It burrows, and is omnivorous like its allies. The two metacarpals that are developed are very long and closely apposed; they have hence a remarkably pig-like aspect, and justify its name. The pouch opens backwards, and there are eight mammae.

Fam. 4. Notoryctidae.—This family contains but a single genus and species, the recently-discovered *Notoryctes typhlops*.[1]

[1] See for an account of this animal, Professor Stirling's Memoir in *Trans. Roy. Soc. S Australia*, 1891, p. 154, and Gadow, *Proc. Zool. Soc.* 1892, p. 361.

We may regard as family-characters the pentadactyle limbs, the existence of three pairs of incisors in the lower and four in the upper jaw; and the tritubercular nature of the upper molars. *Notoryctes typhlops*, the "Marsupial Mole" as it has been termed, was originally discovered by Professor Stirling in Central South Australia. It is a burrowing creature, clothed in a silky fur of a pale golden red, without external ears. It has been compared in appearance with *Chrysochloris*, the Cape Golden Mole, and the eminent palaeontologist, Professor Cope, has even insisted upon a real genetic affinity. Edentate affinities have also been suggested. But *Notoryctes* has a small pouch opening backwards as in other Polyprotodonts,[1] and as it also possesses marsupial bones it must

FIG. 88.—Australian Marsupial Mole. *Notoryctes typhlops.* × ½.

undoubtedly be referred to the Marsupialia. The animal shows many curious adaptations to its underground mode of life. Certain of the vertebrae in the neck and in the lumbar region are firmly welded together, giving of course a strength of push, and suggesting the Armadillos; the claws of the third and fourth front-toes are greatly enlarged, and must be efficient digging organs. The track of the animal is like that of a railway in mountainous country; it burrows for a short distance, emerges, and then descending beneath the surface re-emerges. The red colour of the fur is said to be in harmony with the arid soil in which it lives. The native name of the creature is "Urquamata." It feeds upon ants and other insects.

Extinct Polyprotodonts.—Of extinct Polyprotodonts (apart from those Mesozoic forms which are considered on p. 100) extinct species of *Thylacinus* and *Dasyurus* are known from

[1] The male, according to Professor Spencer, has a rudimentary pouch.

Australia. The most interesting fact in connexion with the Tertiary Polyprotodonts is the existence in South America of such genera as *Prothylacinus* and *Amphiproviverra*, which are not merely Polyprotodonts but definitely Dasyures, and not referable to the Didelphyidae.

These forms have been included in an order, SPARASSODONTA. But it is not by any means certain whether these forms are rightly placed in the neighbourhood of the carnivorous Marsupials, it is possible that they ought to be relegated to the Creodonta or to their allies. Their structure is in fact somewhat intermediate between those two groups. The teeth seem to be carnivorous and Marsupial-like in form, but as already mentioned, in connexion with the general structure of teeth, more than a single premolar is replaced. These animals in fact, in so far as regards their teeth, are midway between the Marsupials and the typical Eutheria: The angle of the lower jaw is inflected, but the palate is not marked by deficient ossification. At least this is not the case with all the members of the group Whether the small *Microbiotherium*, which is made the type of a family, is rightly referred here is not certain. This animal had palatine vacuities as well as an inflected angle to the lower jaw.

CHAPTER VIII

EDENTATA—GANODONTA

Order II. EDENTATA

Terrestrial, partly subterranean, or arboreal creatures of quite small to gigantic size (some extinct genera), with frequently a covering of scales or bony scutes. Limbs clawed. Teeth either totally absent or, if present, imperfect in structure, being without enamel, and not forming a complete series; incisors and canines being as a rule absent. Teats axillary, pectoral, or inguinal.[1] Retia mirabilia very common in the extremities.

To this group the name of Bruta was given by Linnaeus, but then it included not only the families which we now place in the modern order Edentata, but also the Elephant and the genus *Trichechus*. Mr. Thomas has proposed to change the name into Paratheria, which name is suggestive of what he and some others think concerning the systematic position of the group, *i.e.* that it is not to be placed in the Eutherian group of mammals at all, but represents a separate twig which has arisen with the Eutheria from a low mammalian stock. This view can hardly be accepted if the Ganodonta—which will be treated of presently—be really ancestral Edentates, for they are not in any way a Prototherian mammalian group, so far as their remains enable us to judge.

The Edentata contain the Sloths, Ant-bears, Armadillos, *Manis* and *Orycteropus*, among living forms. The great Ground-Sloths, *Megatherium*, etc., and Armadillos, *Glyptodon*, etc., represent the extinct forms.

The name that has been applied to this group is inappropriate

[1] Pectoral and abdominal in the Armadillo *Tatusia*.

inasmuch as many Edentates have teeth. It is, however, by a number of small tooth-characters that the order can be defined. Thus if teeth are present they are simple in structure, without enamel in the adult condition, though a rudimentary enamel-organ has been discovered in an Armadillo. The teeth, moreover, are not found in the anterior part of the mouth, and they grow from persistent pulps, neither is there much differentiation among them. It is not possible, however, to speak of the Edentates as quite homodont, since in *Orycteropus* there are large cheek-teeth; but there is at any rate not a marked heterodonty in that or in any other Edentate. It used to be said that the Edentates were monophyodont. But the Armadillo *Tatusia* was subsequently found to possess a second suppressed dentition, and after this discovery Mr. Thomas proved that *Orycteropus* is also diphyodont. Since then other Armadillos have been shown to be diphyodont; and the whole group therefore, so far as concerns those members that have teeth, may in all probability be regarded as typically mammalian in this respect.

These characters are slender enough, but there seem to be no others by means of which the members of this order can be satisfactorily linked together. The fact is, that we have here a polymorphic order which contains in all probability representatives of at least two separate orders. We have at present a very few, and these perhaps highly modified, descendants of a large and diverse group of mammals. For convenience' sake they will be all treated of under the head of Edentata.

Although for the probable reasons already stated it is a hard matter to frame such a definition as will include all existing Edentates, it is easy enough to define two groups in this heterogeneous order; to define one group we should say, rather, and then to regard the leavings as forming another not so easily definable a group.

The perfectly-definable group is that which includes the American Anteaters, the Armadillos, and the Sloths. In all these creatures, which may certainly be regarded as representing on their own account as many family types, there are a number of important and highly-characteristic anatomical features which they share in common. So exceedingly different are these three types in general appearance and (correlated with that) in way of life that these common characters acquire increased importance.

The first of these characters is the series of additional zygapophyses on the posterior dorsal and lumbar vertebrae; these are very clear in the Anteaters and Armadillos; less clear, but still obviously represented, in the Sloths. In the second place, they all possess a clavicle, rudimentary, it is true, in the

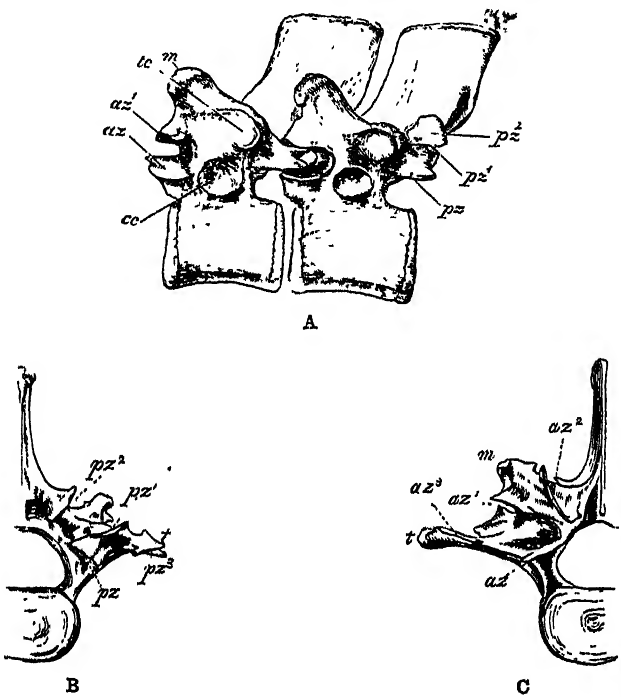

FIG. 89.—Great Anteater (*Myrmecophaga jubata*). A, Side view of twelfth and thirteenth thoracic vertebrae. B, Posterior surface of second lumbar vertebra. C, Anterior surface of third lumbar vertebra. × $\frac{2}{3}$. *az*, Anterior zygapophysis; *az*¹, *az*², *az*³, additional anterior articular facets; *cc*, facet for capitulum of rib; *m*, metapophysis; *pz*, posterior zygapophysis; *pz*¹, *pz*², *pz*³, additional posterior articular facets; *t*, transverse process; *tc*, facet for articulation of tubercle of rib. (From Flower's *Osteology*.)

Great Ant-bear, but still present. Thirdly, the testes are abdominal throughout life, a character which they share with such lowly-organised animals as the Monotremata and the Whales. Finally, and this is by no means a matter to be overlooked, not only are all the existing members of this group American in range, but there is no evidence to prove that they have ever existed elsewhere No European or Old-World repre-

sentatives have as yet been discovered which can be referred to the Anteater, Armadillo, or Sloth type with certainty.[1]

Of these American forms, which will be treated of first, the Armadillos are further apart from either Sloths or Anteaters than the last two are from each other. The name XENARTHRA has been suggested for the American Edentates with "abnormal" vertebral articulations; the corresponding NOMARTHRA includes the Old-World forms.

Between the Sloths and Anteaters the extinct *Megatherium* and some of its allies are to a certain extent intermediate But it may be pointed out in the first place that there are certain important resemblances between the living forms. In both, retia mirabilia are developed in the tail (in spite of its reduction in the Sloths) and in the limbs. But, as is well known, retia are also found in other mammals far removed in the series from these under consideration. The reproductive organs generally are very similar, and they have both a dome-shaped and deciduate placenta The latter character they share with the Armadillos and with the Aard Vark; *Manis* having a non-deciduate placenta which is, like that of the Carnivora, zonary in form. The Edentates, at any rate the American forms, have a double vena cava posterior and no azygos vein. This condition is also met with among Whales.

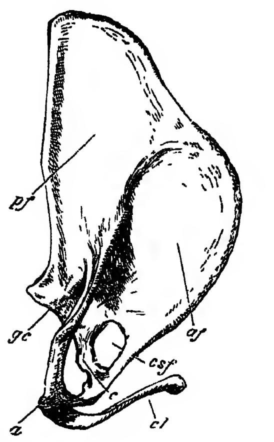

FIG 90.—Right scapula and clavicle of Two-toed Sloth (*Choloepus hoffmanni*). × 1⅜. *a*, Acromion; *af*, prescapular fossa; *c*, coracoid; *cl*, clavicle; *csf*, coraco-scapular foramen; *gc*, glenoid cavity; *pf*, postscapular fossa (From Flower's *Osteology*.)

Osteologically the Sloths and Anteaters are united by the fact that the coracoid becomes fused with the coracoid border of the scapula, thus forming a foramen; the importance of this character is, however, discounted by its occurrence in three genera of Cebidae.

The above facts embody the views of Sir William Flower.[2]

[1] A rather problematical Armadillo, *Necrodasypus*, has been recorded from French strata. It consists of a few scutes only.

[2] *Proc. Zool. Soc.* 1882, p. 358.

A subsequent study of the brain and of the muscles of these animals has led to results not entirely in harmony with these views.

Dr. Elliot Smith is of opinion,[1] after an exhaustive study of the Edentate brain, that in this region of the body the present group shows very decided points of likeness to the Carnivora; that is, so far as concerns the Anteaters. On the other hand, *Orycteropus* is as distinctly comparable with a primitive Ungulate type, such as is exemplified by *Moschus*. "If the brain of *Orycteropus*," he remarks, "were given to an anatomist acquainted with all the other variations of the mammalian type of brain, there is probably only one feature which would lead him to hesitate in describing it as an exceedingly simple Ungulate brain. That one feature is the high degree of macrosmatism.[2] *Manis*, on the other hand, does not come especially near to *Orycteropus*. The brain of *Manis* conforms to a simple type of architecture, which agrees in many points with both those of *Orycteropus* and the American Edentates; there is not sufficient evidence to show which type it really favours." Elliot Smith would, in fact, agree with Max Weber that it is better, if a division is to be made, to divide the group into three orders:—the Xenarthra (Sloths, Anteaters, and Armadillos), Tubulidentata (*Orycteropus*), and Squamata (*Manis*), instead of into Xenarthra and Nomarthra.

Messrs. Windle and Parsons[3] are disposed to see in muscular similarities reasons for uniting *Manis* with the American Edentates, though they confess to being unable to place *Orycteropus*; in this animal, they say, "we are more struck by the generalised mammalian arrangement of its muscles than by any special Edentate characters. There are, however, two muscles in *Orycteropus* which show peculiarities not found elsewhere than in the Edentates";—the triceps, which has more than one scapular head, and the tibialis posticus, which is double. They conclude that *Orycteropus* "presents some feeble claims to be taken into the order"

We shall here adopt the following divisions.

[1] *Trans. Linn. Soc.* (2) vii. 1898, p. 277.
[2] *i.e.* large olfactory lobes.
[3] *Proc. Zool. Soc.* 1899, p. 1014.

SUB-ORDER 1. XENARTHRA.

Fam. 1. Myrmecophagidae.—The family Myrmecophagidae contains three genera, all South American in range. These genera, *Myrmecophaga, Tamandua,* and *Cycloturus,* agree greatly in their outward form They are all without teeth, and have long snouts and long protrusible tongues. The fur is thick, and they have powerful claws wherewith to break down the strong ant-hills upon whose inhabitants they feed. *Tamandua* and *Cycloturus* are arboreal, *Myrmecophaga* is terrestrial in habit

FIG. 91.—Great Anteater *Myrmecophaga jubata.* × $\frac{1}{16}$

The claws of the arboreal forms are useful to destroy the bark, and thus bring to light insects which lurk in such situations.

The genus *Myrmecophaga* contains but one species, the Great Anteater, *Myrmecophaga jubata.* It is a large and handsome animal, with long, shaggy, greyish-black hair and a broad white stripe across the shoulder. The coloration is similar in the two sexes. Including the long and bushy tail it reaches a length of over 7 feet. It is on account of its long tongue and greatly developed salivary glands that this and the allied genera were originally placed with *Manis.* It is the submaxillary glands which are so enormous; they extend back over the chest, and open by three distinct ducts, of which two unite just before the external orifice.

Along their course these ducts are provided with a sphincter muscle, which squeezes the secretion towards the external orifice into the mouth-cavity. The stomach is somewhat gizzard-like. The intestine has no caecum.[1]

The Anteater's great claws are not only serviceable in tearing up the ground to get at its food; armed with them he does not fear, as Mr. Waterton remarked, "the fatal pressure of the serpent's fold or the teeth of the famished jaguar." An Anteater, too, is more than a match for a big dog, and will rip open its belly with the claws while the dog is vainly trying to make an impression with its teeth upon the shaggy hair.

Tamandua is a smaller animal than *Myrmecophaga*, and, as has been stated, is arboreal; associated with this habit is a prehensile tail. Like the last genus, *Tamandua* has a rudimentary clavicle, this bone being well developed in the little *Cycloturus*.

The skull of the Anteater[2] is very long and low; the forepart is tubular, and there appear to be no traces of teeth. The

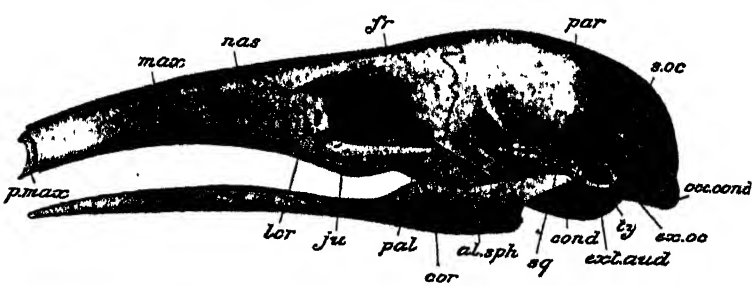

FIG. 92.—Skull of Anteater (*Myrmecophaga*). Lateral view. *al.sph*, Alisphenoid; *cond*, condyle of mandible; *cor*, coronoid process of mandible; *ex.oc*, exoccipital; *ext.aud*, external auditory meatus; *fr*, frontal; *ju*, jugal; *lcr*, lachrymal; *max*, maxilla; *nas*, nasal; *occ.cond*, occipital condyle; *pal*, palatine; *par*, parietal; *p.max*, premaxilla; *s.oc*, supraoccipital; *sq*, squamosal; *ty*, tympanic. (From Parker and Haswell's *Zoology*).

premaxilla is very small; the zygomatic arch is imperfect, and does not reach the squamosal behind. A curious feature of this genus, which it shares with some Dolphins and other Whales, is that the pterygoid bones develop palatine plates which meet each other in the middle line, and thus shift the opening of the

[1] See for anatomy Owen, *Trans. Zool. Soc.* iv. 1862, p. 117, and Forbes, *Proc. Zool. Soc.* 1882, p. 287.

[2] For the skull of Edentates generally see Parker, *Phil. Trans.* clxxvi. 1885, pt. i. p. 121.

posterior nares backwards. This is also, of course, a character of various lower vertebrates. Another Whale-like character in the skull is the weak character of the mandible, which does not give off a marked coronoid process. But then in neither group is there much mastication. The tympanic, periotic and squamosal are ankylosed together. A peculiarity of the cervical

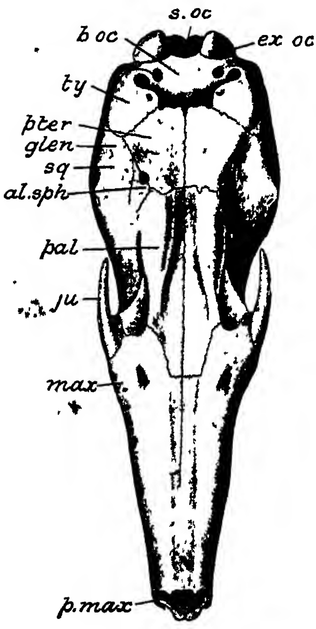

FIG 93.—Skull of Anteater (*Myrmecophaga*). Ventral view. Letters as in Fig 92. In addition, *b.oc*, basioccipital; *glen*, glenoid surface for mandible; *pter*, pterygoid. (From Parker and Haswell's *Zoology*.)

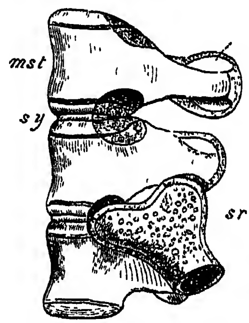

FIG. 94.—Side view of three mesosternal segments of a young Anteater (*Tamandua*), showing the mode of articulation of the sternal rib (*sr*). *mst*, The upper or inner surface of the mesosternal segment; *sy*, the synovial articulation between the segments. (From Flower's *Osteology*, after Parker.)

vertebrae is that (as in the Camels) the vertebrarterial canal of several of the vertebrae perforates the pedicle obliquely. There are fifteen or sixteen dorsal and three or two lumbar vertebrae. The additional zygapophyses upon the former have been already referred to. The mode of articulation of the ribs is highly singular.

Each segment of the sternum (of which there are eight) is separated from the next by a synovial membrane: and it has on either side two facets for articulation with the ribs. The way in

which these latter bones are connected with the sternum is curiously like their mode of connexion with the spinal column at their other end. With this may be possibly compared the double articulation of the single rib (which articulates with the sternum) in the Rorquals. In *Cycloturus* this mode of articulation does not occur.

The manus of *Myrmecophaga* is five-fingered. Of these the third digit (as in Perissodactyles) is the most prominent;

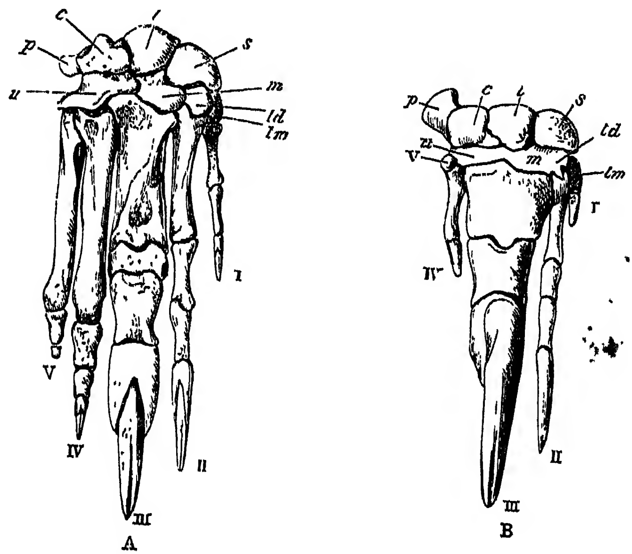

FIG. 95.—A, Manus of Great Anteater (*Myrmecophaga jubata*). × ⅓. B, Manus of Little Anteater (*Cycloturus didactylus*). × 2. *c*, Cuneiform; *l*, lunar; *m*, magnum; *p*, pisiform; *s*, scaphoid; *td*, trapezoid; *tm*, trapezium; *u*, unciform; *I-V*, digits. (From Flower's *Osteology*.)

it is at least double the width of the second or third finger; the pollex is very slender. In the little *Cycloturus* this is carried to a greater extent: the third digit is relatively enormous; the first and the fourth have become quite rudimentary; while the fifth is only just recognisable as a minute ossification.

The chevron-bones in the tail surround a well-developed rete mirabile, a rete being found in precisely the same position in the Eastern *Manis*. *Tamandua* has also retia, which are also found in the Spider-monkeys.

Cycloturus is by far the smallest of the Anteaters. It has

only two toes on the fore-feet. It is to be distinguished, anatomically, from its larger relatives by the complete clavicle, and by the fact that the pterygoids do not meet in the middle line of the skull. The ribs, too, are unusually wide, as in the Whale *Neobalaena*, and form a bony encasement for the body. It has two small caeca. Of fossil Anteaters but little is known. The most interesting form is *Scotaeops*, interesting because it has two small back teeth, which are totally lost in its living allies. The huge Patagonian extinct bird *Phororhacos*, first known by a lower jaw, was at one time regarded as a member of this group on account of the form and edentulous character of the jaw.

Fam. 2. Bradypodidae.—The Sloths, genera *Bradypus* and

FIG. 96.—Unau, or Two-toed Sloth. *Choloepus didactylus*. × ⅛. (After Vogt and Specht.)

Choloepus, come, as already stated, very near to the Anteaters, in spite of their striking difference in appearance. The Sloths are purely arboreal creatures, with strong recurved claws, which serve

as hooks to keep them suspended from the lower side of a branch. The three-toed sloth, *Bradypus* (or "Ai"), has the exceptional number of nine cervical vertebrae; the two-toed sloth, *Choloepus hoffmanni* (or "Unau"), has the equally exceptional number of six. The hair is long and shaggy, and gets an adventitious green colour from the presence of minute algae.[1] This gives to the animal the appearance of a lichen-covered bough, a resemblance which is increased in one species by an oval mark upon the back, which suggests forcibly a broken end of such a branch. The likeness of a Sloth to its surroundings is pointed

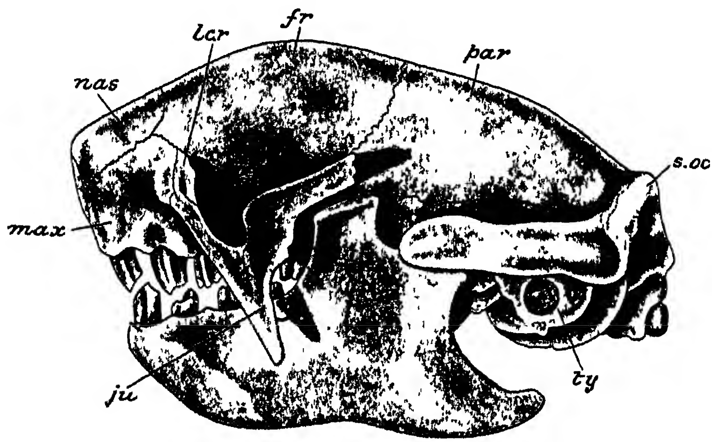

FIG. 97.—Skull of Three-toed Sloth. *Bradypus tridactylus.* Lateral view. *fr*, Frontal, *ju*, jugal; *lcr*, lachrymal; *max*, maxilla, *nas*, nasal; *par*, parietal; *s.oc*, supra-occipital; *ty*, tympanic. (From Parker and Haswell's *Zoology*.)

out by Dr. Siemann,[2] who observed that a species occurring in Nicaragua "has almost exactly the same greyish-green colour as *Tillandsia usneoides*, the so-called 'Vegetable Horsehair' common in the district. . . . If it could be shown that it frequented trees covered with that plant . . . there would be a curious case of mimicry between the sloth's hair and the *Tillandsia*, and a good reason why so few of these Sloths are seen." The stomach in the Sloths is complicated in structure, with several chambers; one of these gives off a long crescent-shaped caecum. The skull of the Sloths agrees in a number of particulars with that of the Anteaters.

[1] The colour fades in captivity owing to the disappearance of the algae.

[2] In a letter addressed to Dr. Gray, quoted by the latter in a revision of the Sloths, *Proc. Zool. Soc.* 1871, p. 428.

The zygoma is incomplete, though the part connected with the frontal has a strong downward process like that found in *Diprotodon*

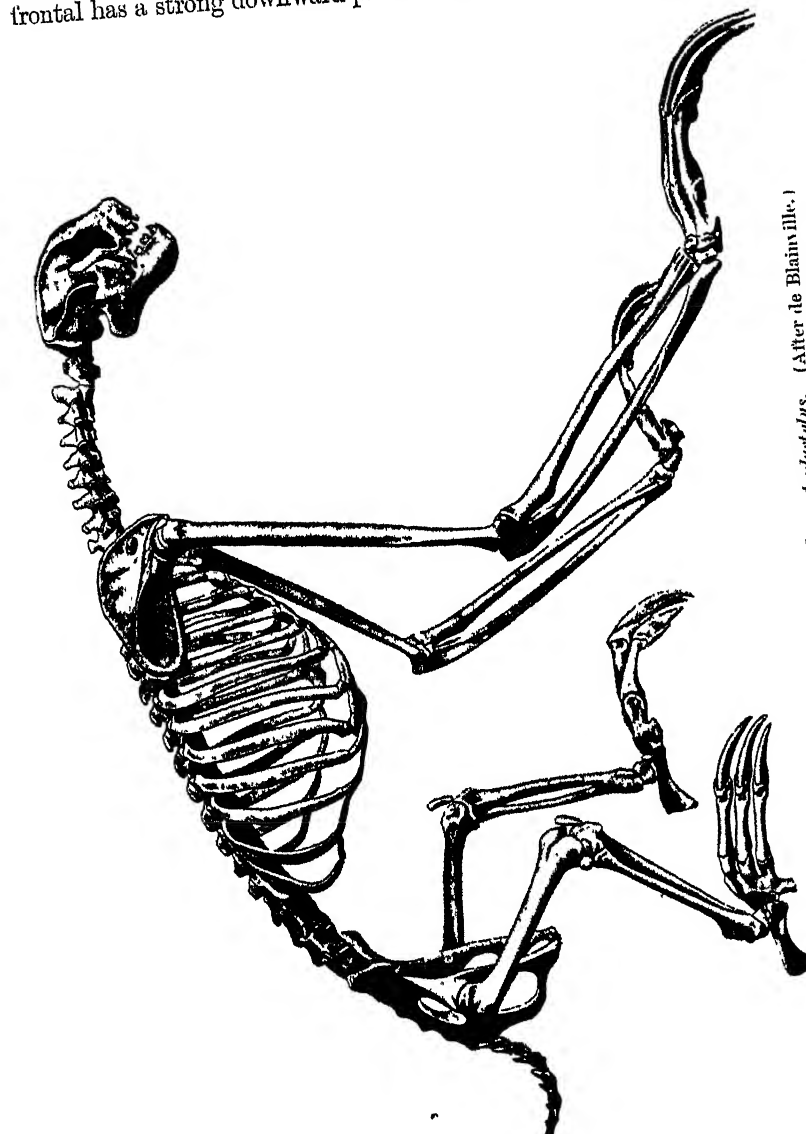

FIG. 98.—Skeleton of Three-toed Sloth. *Bradypus tridactylus.* (After de Blainville.)

and some other mammals. There is, moreover, a process from the squamosal, though it does not reach the anterior part and thus

complete the arcade. The premaxillaries are very small, and are usually lost in dried skulls. Coupled with these points of likeness are some differences. The lower jaw, for instance, has a well-marked coronoid process. The pterygoids do not meet in the middle line. The teeth are five or four in each half of each jaw. There is no trace of a second set.

A peculiarity of the Sloths is the enormous number of dorsal vertebrae. There are twenty-three of these in *Choloepus hoffmanni*, but only fifteen to seventeen in the Three-toed Sloth, *Bradypus*. As in other American Edentates, the acromion joins the coracoid This connexion occurs in both the Two-toed and the Three-toed species. The limbs of these creatures are very long, a concomitant of an arboreal life The femur has no third trochanter. The genus *Bradypus*, which by reason of the fact that it has not lost the third toe on the manus seems to be more primitive than *Choloepus*, shows another structural feature which does not bear out this conclusion. The trapezoid and the os magnum of the carpus are united, while in *Choloepus* they are perfectly distinct bones.

The intestine has no caecum.

There are several species of Sloths. Eminently perfect though the organisation of the Sloth in relation to its particular surroundings appears to us, Buffon selected the animal as the very type of imperfection in nature. "One more defect," he wrote, "they could not have existed."

Fam. 3. Dasypodidae.—The family Dasypodidae or Armadillos contains a considerable number of genera. *Tatusia*, *Tolypeutes*, *Dasypus*, *Xenurus*, *Priodon*,[1] and *Chlamydophorus*. They have all a more or less rigid covering of bony plates imbedded in the skin, which are not in the least comparable with the scales of the Manis. Save the Whales, in one or two genera of which traces of a dermal armature exist, the Armadillos are unique among existing mammals in this particular. The term "Edentate" is especially inapplicable to the Armadillos; the genus *Priodon* may have more than forty teeth in each jaw; a total of ninety was found in one specimen examined by Professor Kukenthal. In the tendency of the teeth to multiply, we have another example of a state of affairs which characterises so many Whales. Generally, however, seven to nine is the number of teeth in each

[1] This name is written "*Prionodos*" by Gray, which might lead to a confusion with the Carnivore *Prionodon*.

half jaw, of which one is often implanted in the premaxilla. The Armadillos show their alliance with the other American Edentates in the points enumerated above. Their teeth specially ally them to the Sloths, while the salivary and digestive organs generally are on the Anteater plan, but present a less extreme development. There are, however, caeca, paired as in birds, in the genera *Dasypus* and *Chlamydophorus*. The others have none But there is a dilatation at the commencement of the large intestine, which is not very different from the slightly-developed caeca of *Dasypus*.

There are certain peculiarities in the skeleton, which distinguish this family.

The skull in the Armadillos presents a number of likenesses to the other American Edentates.[1] The premaxillaries are

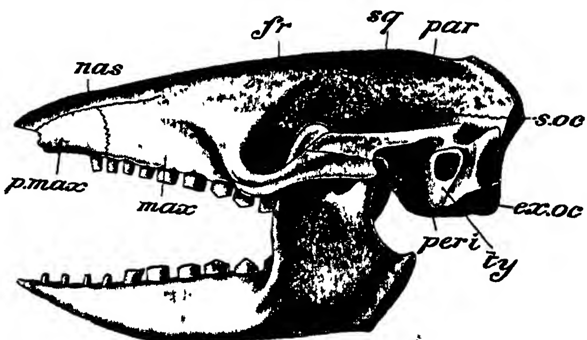

FIG. 99.—Skull of Armadillo. *Dasypus sexcinctus.* ⅔. *ex.oc*, Exoccipital; *fr*, frontal, *max*, maxilla; *nas*, nasal; *par*, parietal; *peri*, periotic; *p.max*, premaxilla; *s.oc*, supraoccipital; *sq*, squamosal; *ty*, tympanic. (From Parker and Haswell's *Zoology*.)

small, but are larger in *Dasypus* than in *Tatusia*. On the other hand the lachrymals are larger in the latter. The zygomatic arch is complete, but there is no downward process as in the Sloths. In *Tatusia* (but not in *Dasypus*) the "short thick pterygoids add somewhat to the hard palate." This is clearly a beginning or a remnant of the quite crocodilian character of the palate of *Myrmecophaga*. In the cervical vertebrae we see the Whale-like character of fusion between individual vertebrae; and also, as in the Whales, the degree to which this fusion is carried out

[1] For the anatomy of several forms, see Garrod, *Proc. Zool. Soc.* 1878, p. 222, who quotes other memoirs.

varies; two to four may be thus united. The additional articular facets upon the dorsal vertebrae have been already commented upon as a point of important likeness to other American Edentates. The dorsal vertebrae are commonly eleven in number, the lumbar being three. But in *Priodon* the numbers are twelve and two respectively. There are traces to be observed of the double-headed attachment of the ribs to the sternum. The

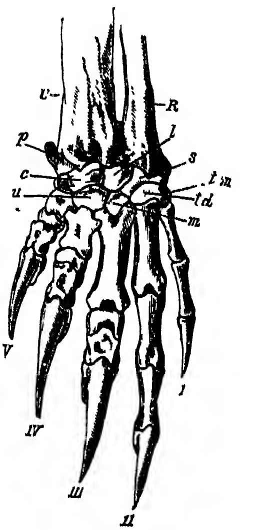

FIG. 100.—Bones of the right manus of the Hairy Armadillo. *Dasypus villosus.* × [illegible]. *c*, Cuneiform; *l*, lunar; *m*, magnum; *p*, pisiform; *R*, radius; *s*, scaphoid; *td*, trapezoid; *tm*, trapezium; *u*, unciform; *U*, ulna; *I*-*V*, digits. (From Flower's *Osteology*.)

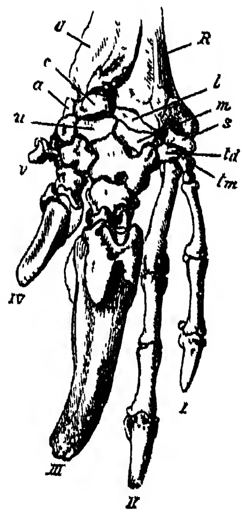

FIG. 101.—Bones of the manus of the Great Armadillo. *Priodon giganteus.* × $\frac{1}{3}$. *a*, An accessory carpal ossicle in front of the pisiform, which is not seen in the figure. Other letters as in Fig. 100. (From Flower's *Osteology*.)

shoulder girdle of the Armadillos is somewhat diverse in form in different genera; the acromion is always large, and is remarkable in *Priodon* for the fact that the humerus also articulates with it, its extremity being recurved, and forming a socket for this purpose. As in some other Edentates there is a second spine on the scapula behind the first. The clavicle is strong. There is some variation in the form of the manus. It is five-fingered in *Dasypus*; in *Tolypeutes* the first digit has vanished; on the other hand, in *Priodon*, the fifth has become rudimentary

and the third enormously enlarged. This latter fact recalls the arrangement characteristic of *Myrmecophaga*. The pelvis is greatly attached by the ischium to the vertebral column. The femur has a third trochanter.

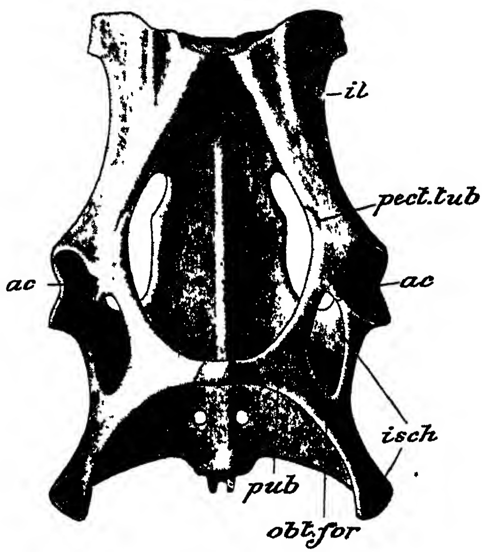

FIG. 102 —Pelvis and sacrum of Armadillo. *Dasypus sexcinctus*. *ac*, Acetabulum; *il*, ilium; *isch*, ischium; *obt.for*, obturator-foramen; *pect.tub*, pectineal tubercle, *pub*, pubis (From Parker and Haswell's *Zoology*.)

The various forms of Armadillos are largely distinguished by the number of movable thin bands of scutes lying between the large anterior and posterior shields. Thus we have *Dasypus sexcinctus*, *Tolypeutes tricinctus*, etc.

The little Pichichago (or, more correctly, Pichy-ciego), *Chlamydophorus*, which only grows to about 5 inches in length, has no movable bands at all. It is covered with a uniform series of plates, which, moreover, are not discontinuous at the neck. It differs, too, from the prevailing Armadillo-type by the absence of conspicuous external ears. In the anterior part of the body the armature consists of little more than the horny plates, which in other Armadillos overlie the bony dermal plates. In the hinder region the bony plates are strong. In this animal, therefore, we have the dermal armature reduced to a minimum; but it must be noticed that, like the extinct Glyptodons, the armature is continuous and nowhere ringed.

The genus *Tolypeutes*, of which the best-known species is *T. tricinctus*, the Apar (there are two other species in the genus), can roll itself up into a ball like the Pill-Millipede (*Glomeris*), and, protected by its armour, roll away from its enemies like the Arthropod under similar circumstances. This mode of protection, be it observed, is also adopted by the Pangolin and by the Hedge-

hog. The genus has only three movable bands. The tail is short, and is covered with large tubercles. This genus is very markedly digitigrade when running.

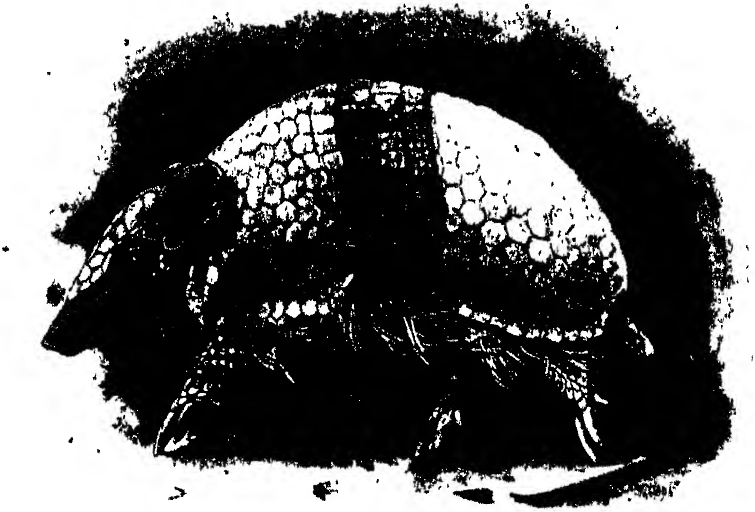

Fig. 103.—Three-banded Armadillo or Apar. *Tolypeutes tricinctus.* × ¼.

The Peludo, *Dasypus sexcinctus*, is, like other Armadillos, an

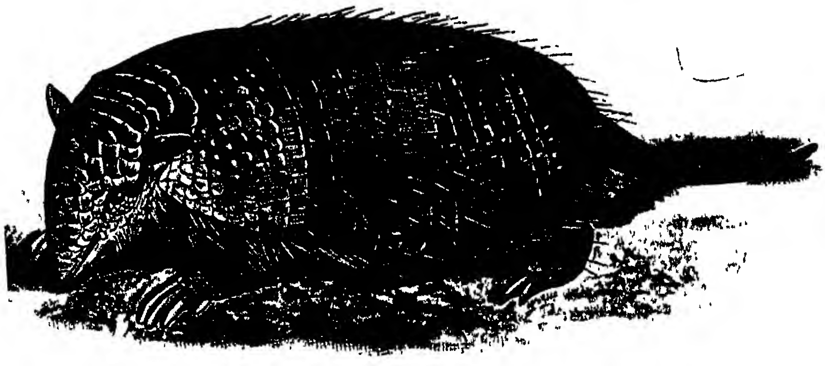

Fig. 104.—Peludo Armadillo. *Dasypus sexcinctus.* × ⅓. (After Vogt and Specht.)

omnivorous creature, and appears to be particularly fond of carrion. will burrow up to a decaying carcase like the ground-beetles.

Mr. W. H. Hudson has described the way in which this Armadillo will kill a snake by holding it down and literally sawing the reptile in half by help of the sharp and serrated edges of the carapace. *Dasypus* has a very short tail, which is shielded by distinct rings near the base.

Tatusia novemcincta is a species with nine movable bands. The genus has four teats; the ears are near together. There are no caeca and no azygos lobe to the lung. A species apparently belonging to this genus, but described under the generic names of *Cryptophractus* and *Praopus*, is remarkable for the thick covering of hair, not entirely wanting but usually thin in other Armadillos. In this particular species the coat of hair is so thick as to conceal the underlying plates of the carapace. The individual hairs are stiff, and one inch and a half in length.[1]

The genus *Xenurus* contains several species, the best known of which is inaptly named *X. unicinctus*. As a matter of fact the characteristic feature of the genus is the existence of twelve or thirteen movable plates between the two ends of the body. *X. unicinctus* has twelve dorsal and three lumbar vertebrae. This Armadillo, known by the vernacular name of the Cabassou, has one of the most modified hands that are found in the family. The first two digits are slender and elongated; but are quite normal in the number of their phalanges. In the remaining three digits the metacarpal is short and broad, while the proximal phalanx is either suppressed altogether or fused with the metacarpal, the middle phalanx is present but short, while the third phalanx is very large indeed. As in *Dasypus*, but not as in *Tatusia*, which is in so many other respects divergent from these genera, the lungs have an azygos lobe. As a small point of difference, tending to show an alliance between the genera *Xenurus* and *Dasypus* and their difference from *Tatusia*, is the deeply-imbedded gall-bladder; this sac is not nearly so deeply plunged into the hepatic tissue in *Tatusia*. *Xenurus* has no caecal dilatations. The brain "is intermediate in its form and surface markings between *Dasypus* and *Tolypeutes*." The small intestine is nearly eighteen times the length of the large. But these intestinal measurements are not of much avail in this group as marks of affinity, since in three species of *Dasypus* Garrod gives the following widely-divergent lengths:—*D. villosus*, 11·5 feet and 1·25; *D. minutus*

[1] Flower, *Proc. Zool. Soc.* 1886, p. 419.

5·1, with a large intestine of no less than 7 feet; *D. vellerosus* 4·3 and ·66.

Priodon is the giant of its race. This Armadillo may reach a length of 3 feet to the base of the tail. The tail is some 20 inches long. The large number of teeth has been already noticed. There are twelve or thirteen bands. Other points in the structure of this genus have already been mentioned, and need not be recapitulated. This Armadillo feeds upon termites and carrion.

Scleropleura is unfortunately but imperfectly known. The single species, named by Milne-Edwards[1] *S. bruneti*, is apparently a very rare inhabitant of Brazil. It is known by a single skin, which was tanned by the hunter who obtained it. Thus the hair, if any, has dropped out. The plates in the skin are deficient along the back and even upon the top of the head, and are barely represented upon the tail posteriorly. The ears are small and distant from each other. The tail is longish, about one-third of the length of the body. The total length of the creature including the tail is rather more than a foot and a half. The hunter who obtained it regarded it as a hybrid between an Armadillo and an Anteater.

Extinct Xenarthra.—There are a good many extinct forms of Armadillo, apart of course from the Glyptodons. *Peltephilus* is referred to later (p. 186). *Dasypus* was represented by a large form, 6 feet long, with a skull of one foot in length. The genus *Eutatus* was also large. The carapace was formed of thirty-three distinct bands, of which the last twelve are soldered together, but not fused into a shield as in *Dasypus*, etc.

An extinct group of American Edentates, termed the GRAVIGRADA,[2] are somewhat intermediate between the Sloths and the Anteaters. A number of the genera are well known from complete skeletons.

One of the typical forms of this group is *Mylodon*, which, together with its immediate allies, is often placed in a separate family, **Mylodontidae.**

Mylodon itself was a large creature, as big as a Rhinoceros. It was covered externally by armour in the skin, which did not form a massive armature as in the Glyptodonts, but was in the

[1] Milne-Edwards, *Nouv. Arch. Mus.* vii. 1871, p. 177.
[2] See especially Lydekker, *An. Mus. La Plata, Pal. Arg.* iii. 1894.

form of scattered plates, small and not fused together. The general aspect of the skull is decidedly Sloth-like. As in that animal, the malar bone is bifid posteriorly, and between the bifurcation is embraced the process of the squamosal. This latter is thus more developed than in the Sloth, but there is no actual union between it and the malar. The premaxilla is small. The lower jaw has both coronoid and ascending processes, and is massive. There are five teeth on each side above, and four on each side below, as in the Sloths. There are the normal seven cervical vertebrae and sixteen dorsals. The limbs are not long and slender, but short and strong, the animal having been terrestrial. The fore-feet were five-toed, of which the three inner toes had claws. The hind-feet were only four-toed, and the two inner only were clawed.

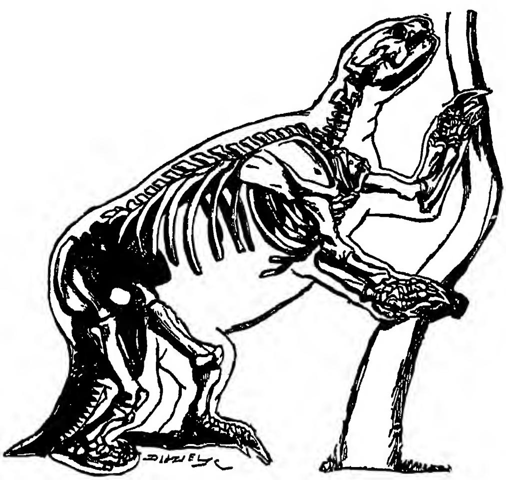

FIG. 105.—*Mylodon robustus.* (Restoration, after Owen.)

Scelidotherium is a genus which is a trifle smaller than the last. It has only four properly-developed toes in the fore-foot, the thumb being rudimentary; of these, the first two bear claws. The hind-feet are also four-toed. Like *Mylodon*, *Scelidotherium* is a Pleistocene genus.

Glossotherium has a skull very much like the last two genera; but it is remarkable for the fact that the nostrils instead of being unprotected with bone anteriorly are there closed by a plate of bone formed by the well-developed premaxillae, the nostrils appearing at the sides, and giving the skull a curious likeness to that of a Chelonian. From a series of recent and most important observations it appears to be clear that this genus has survived into quite modern times.[1]

[1] Dr. Moreno and Mr. A. Smith Woodward in *Proc. Zool. Soc.* 1899, p. 144; *Wiss. Ergeb. Schwed. Exped. Magellansland.* ii. 1899, p. 149.

The well-known naturalist of La Plata, Señor Moreno, engaged in studies connected with the political boundary line between Chili and the Argentine, had occasion to visit Consuelo Cove on Last Hope Inlet in Patagonia. Hanging from a tree he noticed a piece of dried skin, which at once struck him as looking more like the remains of a Mylodon than of any living animal. The inhabitants regarded this piece of skin as a great curiosity, but were of opinion that it was the hide of a cow encrusted with peebles! This fragment from a bygone age was originally described by Professor Ameghino, who had apparently seen some of the bonelets imbedded in it, as *Neomylodon listai*, "a living representative of the ancient Gravigrade Edentates of Argentina." That this piece of skin is of quite recent date seems to be proved by a number of considerations. In the first place it is covered by long hair of a light yellowish-brown colour; it does not seem likely that hair would preserve its character for geological epochs. The nearest corresponding case is that of the remains of Moas in New Zealand, whose feathers, dried skin, and tendons are known. Now the Moa was unquestionably contemporaneous with man, as abundant surviving legends prove, and indeed it cannot have been long extinct. Still, hair is a resisting structure, and in a dry cave, with no possibility of irruptions of floods, might retain its characters for long periods. The evidence, however, of more recent date is stronger than this. The skin shows patches of reddish colour, suggestive of course of blood-stains. A small piece of the outside of the skin at the cut edge, which presented the appearance of freshly or comparatively freshly dried fluid, was submitted to a chemical examination and shown to be serum! Dr. Lonnberg examined chemically a bit of the skin itself and found in it, after boiling, glue, "which proves that the collagen and gelatinous substances are perfectly preserved" After this it seems impossible to suppose that the skin can be of any very great age; for bacteria would have finished their work upon the serum and gelatine long ago. Combined with the fresh appearance of the skin is the very fresh appearance of the skull. In fact it is impossible to believe that the animal was not alive quite a few years since, relatively speaking. It is admitted that this animal was contemporaneous with man. There are actually legends of a creature which may have been this *Glossotherium*. "Ancient chroniclers inform us that the indigenous inhabitants recorded the existence of a

strange, huge, ugly monster, which had its abode in the Cordillera to the south of latitude 37. The Tehuelches and the Gennakens have mentioned similar animals to me, of whose existence their ancestors had transmitted the remembrance, and in the neighbourhood of Rio Negro, the aged Cacique Sinchel, in 1875, pointed out to me a cave, the supposed lair of one of these monsters, called 'Ellengassen', but I must add that none of the many Indians with whom I have conversed in Patagonia have ever referred to the actual existence of animals to which we can attribute the skin in question."

A rude painting in a cavern, in red ochre, seems to Dr. Moreno (whose words we have just quoted) to be somewhat suggestive of a *Glyptodon*. There are some reasons for believing that this quadruped was kept by man as a domestic creature. In the cave are two walls of rough pieces of stone which seem to have dropped down owing to the wearing away of the roof; they also seem to have been loosely piled together to form two walls, within which enclosure an imperfect skull of the animal was found. This skull shows clearly that the so-called "*Neomylodon*" must be referred to *Glossotherium* or *Grypotherium*, as it is sometimes termed. This skull is perforated on the roof in such a way as could only have been effected (in the opinion of experts) by a weapon in the hand of a man. A hole in the skin has been even compared to a bullet-wound. But this it is perhaps unnecessary to discuss. The skin of *Glossotherium* is, like that of other extinct "Ground-sloths" (*e.g. Mylodon*), filled with small and irregular ossicles. But in *Mylodon*, the sculptured appearance of the dermal ossicles appears to indicate that they reached the surface of the body and were covered by epidermis alone, which is not the case with the animal now under consideration. The microscopic characters of the ossicles, too, show differences in the two. *Glossotherium* being "precisely intermediate between *Mylodon* and the existing Armadillo (*Dasypus*)." Now *Glossotherium* and *Mylodon* are regarded as forms which lie between the existing Anteaters and the Sloths of the same part of the world. We have already pointed out the facts of structure which lead to this conclusion. It might therefore be reasonably surmised that the hair of *Glossotherium* would be also intermediate, or at least like that of one of the two genera *Myrmecophaga* and *Bradypus*. But microscopical investigation has

negatived this supposition It has shown that the Armadillos are in this matter the nearest relatives of *Glossotherium*. This result is important as tending further to confirm the close inter-relationship of all the American Edentates as contrasted with the Old-World forms—a matter which has already been emphasised It is suggested, however, that the absence of under fur, which is so well developed in the Sloth, and the difference shown in transverse sections from the hair of *Myrmecophaga*, may be explained by difference in habitat. *Glossotherium* lived under conditions similar to those under which the Armadillos live to-day. Thus the outer covering of the body became alike in the two cases, the same needs supervening in both genera.

Lestodon is another allied genus, which seems to possess canines. At any rate, in front of the four molars, and separated from them by a diastema, is a smallish, somewhat canine-like tooth, in both jaws.

Megalonyx and its allies are sometimes placed in a distinct family, **Megalonychidae.** *Megalonyx* itself had a skull very like that of *Bradypus*, being shorter and not so elongated as in the Mylodontidae. There is a strong tusk anteriorly, which is separated by a considerable space from the three molars lying behind it. Both pairs of limbs seem to have possessed five toes. This is a North American genus. It differs from the bulk of the American Edentates in having a complete jugal arch.

Megatherium is the type of yet a third family, **Megatheriidae,** of the Gravigrade Edentates. This creature is familiar from the many restorations which have been built up, and from its huge bulk, little short of that of an elephant. The skull, which is small for the size of the creature, has a complete jugal arch, from the middle of which depends a downward process as in other allied forms. The teeth grow to an extraordinary depth, and there are five of them in the upper and four in the lower jaw—on each side of course. The fore-limbs of the *Megatherium* are very much more slender than the enormously bulky hind-limbs, upon which and the equally massive tail the animal seems to have supported itself while tearing down branches of trees, upon whose leaves it fed. In the scapula the acromion joins the coracoid as in *Bradypus;* the clavicle is large. The fore-limb is four-toed, and the hind-limb three-toed. The latter has but one clawed digit (the third, *i.e.* the inner).

On the manus, the three inner digits have powerful claws. This animal, too, was Pleistocene in time. The Megatheriidae had, however, small as well as gigantic forms

The genus *Zamicrus* had a skull no bigger than that of a Sloth, while *Nothrotherium* was also a comparatively small creature; the teeth of the latter genus are reduced to $\frac{4}{3}$.

The extinct group of the **Glyptodontidae** comprises large creatures with a dense covering of bony scutes which are arranged in a tesselated fashion, and thus form an immobile armature of immense strength. In correspondence with this massive carapace the dorsal vertebrae have fused together, and the lumbar vertebrae form a series ankylosed to each other and to the following sacrals. These creatures are all South American.

Glyptodon, the genus which gives its name to the family, is known from numerous remains in South America, and also from

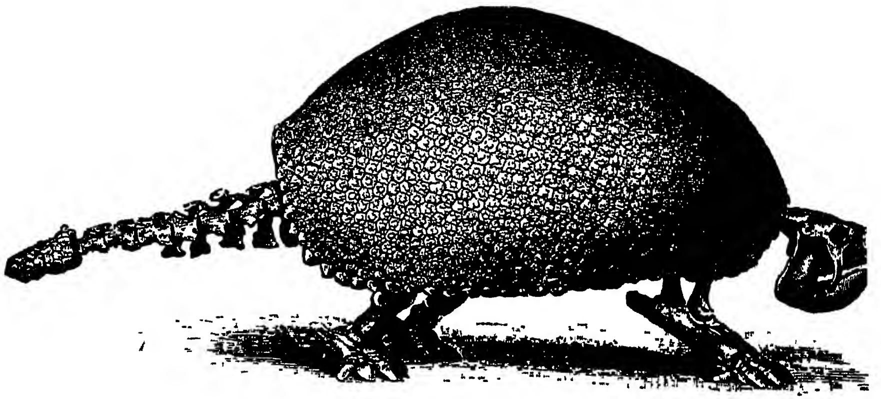

FIG. 106.—*Glyptodon clavipes*. × $\frac{1}{13}$. (After Owen.)

so far north as Texas and Mexico. It grew to be as long as 16 or 17 feet. In the skull there is an exceedingly long downward process of the zygomatic arch, as in Sloths, the arch itself being complete. The process extends so far down as to reach a point about on a level with the middle of the lower jaw. The nasals are short or rudimentary. As in *Myrmecophaga*, the pterygoids enter into the formation of the bony palate. The lower jaw has a spout-shaped extremity, and, behind, it rises into an enormous vertical branch as high as the front part of the jaw is long. There are eight teeth in each half of each jaw. As in

some Armadillos, the cervical vertebrae are at least partly fused The atlas is free, but the rest, or at any rate five of them, are united. The last cervical is sometimes fused with the succeeding dorsals; the latter are twelve in number, and are fused together so far as concerns their centra and neural processes. The succeeding region of the vertebral column includes seven to nine lumbars, which are fused with the eight sacrals; in this region the neural processes are high, and there is thus produced a strong and lofty ridge along the back, which forms a powerful support for the carapace. The fore-limbs are shorter than the hind-limbs, which latter are attached to an unusally massive pelvis. The claws of the limbs are blunt and almost hoof-like.

The heavy carapace consists of sculptured, five or six-sided plates, which have no particular arrangement in the middle, but towards the margins show indications of an arrangement in transverse rows. The moderately long tail is also encircled by bony skin-plates which are thorny above, or at least provided each with a blunt upstanding process. It appears that outside this bony system of scutes were horny epidermic scales, corresponding exactly with the tesserae which they cover. There are apparently a good many species of *Glyptodon*.

In the allied genus *Panochthus* the tail is rather longer, and the bony rings which surround it, instead of being all movable as in *Glyptodon*, are at first so, but later, *i.e.* towards the end of the tail, become welded into a single and massive piece. Both feet are here four-toed, while in *Glyptodon* the hind-feet are five-toed and the fore-feet four-toed.

Daedicurus shows a further specialisation, in that the feet have three and four digits respectively. The orbit too shows a specialisation in being separated from the temporal fossa. The descending process of the zygomatic arch is not so extraordinarily exaggerated as it is in *Glyptodon*. It has the same terminal tube of osseous scutes upon the tail. This creature seems to have reached a length of about twelve feet.

Propalaeohoplophorus is, unlike the great Armadillos that we have hitherto dealt with, a small animal, not exceeding 2 feet or so in length of carapace. A small alveolus on each side of the premaxillae seems to suggest the former presence of an incisor tooth; and it seems that the animal possesses both true molars and premolars; for the first four of the eight teeth are much

simpler in structure than those which follow. The dorsal vertebrae again are not fused together; the hind-limbs are five-toed. All the plates of the carapace are arranged in definite transverse rows; it has been observed, too, that some of the anterior scutes overlap like those of the Armadillos, to which this animal possesses further likenesses in the exclusion of the maxillae from the border of the nostril (a Glyptodont character), and the comparative feebleness of the scutes.

A primitive genus also appears to be *Peltephilus*, which is perhaps rather an Armadillo than a *Glyptodon*. However, it comes somewhat between the two, like *Propalaeohoplophorus*, with which it may therefore be treated. A most singular feature of this genus has been mentioned on p. 27 in connexion with the skull in the Mammalia generally. That is the fact that a portion of the squamosal surrounding the articular facet for the lower jaw is separated by a suture from the rest of that bone, and is therefore obviously suggestive of the quadrate in the lower Vertebrates. As in certain Armadillos and Glyptodons, etc., the pterygoids appear in this genus to have taken a share in the formation of the hard palate. The plates of the carapace were movable, as is shown by the fact that they sometimes slightly overlap. In view of the possible origin of the Edentates from lowly-organised Mammalia, it is noteworthy that the humerus has been especially compared to that of the Monotreme. *Peltephilus* differs from other Armadillos in having teeth in the front of the jaws. The total number of teeth is twenty-eight, *i.e.* seven in each half of each jaw.

SUB-ORDER 2. NOMARTHRA.

As already explained, the Old-World Edentates differ from the New-World forms in having normal dorsal vertebrae, that is to say, without additional zygapophyses. That negative feature, however, though combined with the positive fact that both the Old-World forms feed upon ants, is hardly sufficient to outweigh the many structural differences which distinguish the Orycteropodidae from the Manidae; which will be placed therefore in different groups. To that containing the Aard Vark, the name TUBULIDENTATA may be applied.

This group contains but one family, the **Orycteropodidae**, of which there is but a single genus.

The Aard Vark (earth-pig), genus *Orycteropus*, is characterised by its heavy build, the body being covered by rather coarse and not very abundant hair, the snout is long and pig-like, with round nostrils at its end; the ears are long, erect, and pointed; the tail is very thick at first, so that it has been aptly described as "a tapering of the body to a point." The fore-limbs are four-toed, the hind five-toed.

FIG. 107.—Aard Vark, or Cape Anteater. *Orycteropus capensis.* × $\frac{1}{16}$.

In the skull there is a complete though slender zygoma; the premaxillaries, though small, are not so rudimentary as in the American Edentates. The annular tympanic is not ankylosed to the surrounding bones, a character found in other low mammals. Contrary to what is found in *Manis*, *Orycteropus* has a huge lachrymal. There are thirteen dorsal and seven lumbar vertebrae. The clavicle is well developed. *Orycteropus* is peculiar among Edentates in that the ischia do not unite with the vertebral column. The femur has a third trochanter.

As mentioned on p. 162, the Aard Vark is diphyodont like normal mammals. The permanent teeth consist of five molars and premolars on each side of each jaw; the first two of these are premolars, and are simpler in their form than the succeeding two teeth, which are partly divided by a median furrow into two halves. These teeth are also peculiar in that they consist entirely of vaso-dentine. They have been compared in minute structure to those of the Ray *Myliobates*. According to Mr. Oldfield

Thomas[1] there are seven milk teeth on each side of the upper jaw (limited to the maxillae, and thus not incisors). An eighth tooth was discovered on one side of one of the specimens examined by Thomas. In the lower jaw there are only four milk teeth on each side. It is interesting to note that the histological structure

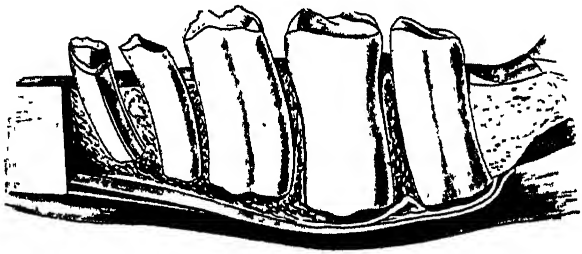

FIG 108.—Section of lower jaw with the teeth of *Orycteropus*. × 2. (After Owen.)

of these milk teeth agrees with that of the permanent teeth. There are two species of this genus found in Africa: the southern, *O. capensis*, is more hairy than the northern, *O. aethiopicus*. *O. gaudryi* is a Pliocene species from the Island of Samos and from Persia, described by Dr. Forsyth Major and Dr. Andrews[2] It closely resembles the existing *O. aethiopicus*.

Of the Scaly Anteaters, Group SQUAMATA or **Manidae**, there is really but one genus, though *Phatagin*, *Pholidotus*, *Smutsia*, and *Pangolin* have been used to distinguish various forms. The genus *Manis* is African and Oriental in range. Dr. Jentink, who has lately revised the species, allows seven[3] The external form of these animals is fairly well known, the remarkable scales distinguishing the Pangolins from other animals. Between the scales lie hairs, which seem to be absent in the adults of the African species, though present in the young, thus affording a convenient method of distinguishing the Ethiopian from the Oriental forms. The scales have been compared to agglutinated hairs. That they are not "merely mimetic of the Lizards' scales" is held by Weber,[4] who compares them directly with those struc-

[1] *Proc. Roy. Soc.* xlvii. 1890, p. 246.

[2] *Proc Zool Soc.* 1893, p. 239, and 1896, p. 296.

[3] "Revision of the Manidae in the Leyden Museum," *Notes Leyd. Mus.* iv. 1882, p. 193

[4] Weber, *Zool. Ergebnisse einer Reise in Niederl. Ost Indien*, 1892. See also Romer, in *Jen. Zeitschr.* xxxi. 1896, p. 604, and Reh, *ibid.* xxx. 1895, p. 137.

tures, as he does the scales of other mammals, such as those upon the tail of *Anomalurus*, etc. This, however, is not a universal opinion. It is true that these scales occur chiefly in the lower forms of mammals such as those under consideration, Marsupials, Rodents, and Insectivores; but the fact that the hairs are developed before the scales shows, or seems to show, that the former are the older structures, and to lead to the inference that the scales of mammals are new structures. The scattered hairs of the Pangolin have no sebaceous glands excepting on the snout. This, again, looks as if they were degenerate structures, and emphasises the non-archaic character of the scales. These animals have no trace of teeth except possibly some slight epithelial thickenings which have been interpreted as a last remnant; the tongue is suited for the capture of ants, and is therefore much like that of the not nearly-related American Anteaters. The stomach is of simple form: it is characterised by a large gland, which suggests that of the Koala (see p. 144); the intestine has no caecum. Retia mirabilia occur on the limb arteries. The placenta is non-deciduate and diffuse; it is specially compared by Weber with that of the Horse. Considering the many adaptive resemblances between this genus and the American Anteaters, especially in the mouth cavity, it is remarkable that in *Manis* the pterygoids are not joined as they are in *Myrmecophaga*. In spite of statements to the contrary, it appears that there is sometimes a distinct lachrymal.

A remarkable feature in the skeleton of *Manis* is the singular sternum. The xiphoid cartilage is extraordinarily elongated into thin strips, which reach the pelvis and return. This state of affairs is to be found in the African species only. This structure is not comparable, as it has been said to be, with abdominal ribs such as those of the reptile *Hatteria*.

These animals are mainly anteaters. The Japanese have a curious legend as to the method adopted for the capture of ants, which is related by Dr. Jentink in his monograph of the genus. The Manis "erects his scales and feigns to be dead; the ants creep between the erected scales, after which the anteater again closes its scales and enters the water; he now again erects the scales, the ants are set floating, and are then swallowed by the anteaters"! The same story is related by Mr. Stanley Flower on the authority of the Malays.

Though it seems clear that the likenesses which *Manis* shows

to the Anteaters of the New World are chiefly adaptive and have nothing to do with real affinity, being merely an expression of a similar mode of life, it is curious to note that here and there we do find certain resemblances which do not seem to be susceptible of the latter explanation. The jugal bone, absent in *Manis*, is small in *Myrmecophaga*, the clavicle is absent and again small or rudimentary in the Anteaters; it is large in other Edentates.

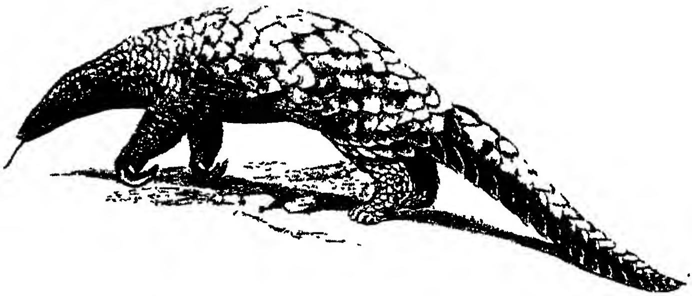

FIG 109 —Manis. *Manis gigantea.* × 1/12.

The third trochanter is absent, as in *Myrmecophaga* (and the Sloths). There are many scales on the body; in *Myrmecophaga* there are traces of these structures on the tail, as also in *Tamandua*. In the features mentioned, the Myrmecophagidae differ from either or from both of the two other American families (*i.e.* Dasypodidae, Bradypodidae) and agree with *Manis*. The facts are not a little remarkable

Order III. GANODONTA.[1]

Allied to the Edentata, and apparently representing the ancestral forms from which they, at any rate the Xenarthra were derived, is the order of the Ganodonta. Of this order a number of genera are now known, which can be ranged in a series which more and more approaches the Edentata as we pass from the older to the newer forms. This interesting and transitional series will be made manifest by a description of the characters of the various genera taken in their proper chrono-

[1] See Wortman, "The Ganodonta and their Relationship to the Edentata," *Bull. Am. Mus. Nat. Hist.* ix. 1897, p. 59.

logical order. The following genera are included by Wortman in his family **Stylinodontidae.**

The earliest type of the Ganodonta is the genus *Hemiganus*, with but one species, *H. otariidens.* This animal lived during the deposition of the lowest Eocene strata, the Puerco beds of North America. It was about as big as a fair-sized Dog, and had powerful jaws. There were at least two pairs of incisors in the upper jaw, together with powerful canines and the full premolar and molar formula. In the lower jaw the canines were also strong, but the incisors are not certainly known to be more than two pairs. The enamel upon the posterior surface of the canine is thin, and in the case of the incisors the enamel seems to be limited to the anterior face. The lower molars are quadritubercular. It is believed from the presence of a suture on the upper surface of the premaxillary that the snout of the creature was tubular. The cervical vertebrae, only known by their centra, are like those of the Armadillos (and for the matter of that of the Whales) in the great transverse as opposed to the antero-posterior diameter. The feet are especially compared with those of the Ground Sloths. The single ungual phalanx is marked by a large subungual process, which is pierced by a considerable foramen. The tibia again is to be compared with that of the Armadillos.

In the Upper Puerco (Torrejon) beds the remains of *Psittacotherium* are found. This genus, when first discovered, was referred to the Tillodontia by some and to the Ungulates, the latter being a refuge for indeterminate Eocene mammals, just as the "Multituberculata" is for similarly-placed Secondary mammals. It is now known to be clearly a member of the order Ganodonta. Wortman thinks that there is but one species, *P. multifragum.* It seems to have had a general aspect much like that of *Hemiganus*—that is judging from the skull—and was not very greatly different in size. The facial portion of the skull is short, and the zygoma is deep. The infra-orbital canal is double, a feature which crops up in the Sloth, and has been mentioned in the later form of Ground Sloth, *Megalonyx* (but it must be remembered that the same characteristic is not unknown in Rodents). The dentition is reduced as compared with that of *Hemiganus*, that is to say, as far as concerns the molars and the incisors. There is but a single pair of incisors in each jaw; the canines are strong; the premolar and molar series seem to have been complete in the lower jaw,

but reduced by one premolar at least in the upper jaw. It is very important to notice that the incisors have enamel only on their anterior faces, and that the same is the case with the canines, the slender layer present behind the tooth in *Hemiganus* having vanished in this later form. The tooth pattern of the molars is like that of *Hemiganus*. The fore-limb is decidedly Edentate-like; but it is the foot which presents the strongest likenesses to that order. "If an anatomist," remarks Dr. Wortman, "had no other part of the skeleton than that of the foot to guide his judgment, and he should fail to detect a most striking similarity between it and that of the Edentata, especially the Ground Sloths, he would not only lay himself open to the criticism of being lacking in the ordinary powers of observation and comparison, but would be suspected of placing the matter upon a basis other than that established by such a method." It is not certain how many toes upon the fore-limbs were possessed by *Psittacotherium*, but the close resemblance to *Mylodon* is indeed striking, the third digit being in both forms the most pronounced. Some vertebrae of this Ganodont have been discovered which do not show the complex articular arrangements of later American Edentates. The sacrum, on the other hand, is very like that of the Sloth, and there is a foreshadowing of the attachment of the ilia to the sacrum by co-ossification which is met with in later Edentates. A still later type is the genus *Calamodon*, which has been shown to occur in Europe as well as in America. *C. simplex* was a larger beast than either of the genera that have already been treated of, thus affording another example of the increase in size of later as compared with earlier members of the same group, so pronounced among the Ungulata. The lower jaw has the same massive structure that characterises that bone in *Hemiganus* and *Psittacotherium*. There is but one incisor, but the premolar and molar series are complete. The canine is Rodent-like in appearance, being imbedded throughout the greater part of the lower jaw; it evidently grew from a persistent pulp. It is enamelled upon the anterior face only. The premolar and molar teeth are in this genus commencing to lose their enamel, which is distributed in the form of vertical bands, leaving interspaces which are not covered by enamel. These teeth, moreover, are decidedly hypselodont, more decidedly so than in *Psittacotherium*; they are, when unworn, quadricuspidate, with accessory cusps; when more worn, the teeth

are double-ridged, and that transversely to the long axis of the jaw; finally, the much-worn teeth have flattish crowns more or less surrounded by a ring of enamel.

A still later form, coming from the Lower and Middle Eocene strata, is the genus *Stylinodon*. *S. cylindrifer*, which is the more archaic of the two described species, is only known from a single molar, fragments of a canine, and "some inconsiderable pieces of the skull." The molar is interesting on account of the fact that the enamel is still further reduced; it is represented only by narrow vertical strips, which are much narrower than those of older forms of Ganodonts. It is also hypselodont, and has a persistent pulp. So, too, the canine which had a thick anterior facing of enamel. The later species, *S. mirus*, is more fully known. The teeth seem to have been much the same as in the last-described species; the premolars and molars were seven in all in the lower jaw, and the canine was imbedded in the bone for a long distance, as in *Calamodon*. The cervical vertebrae have short centra as in *Hemiganus*. The clavicles were well developed. The humerus possessed an entepicondylar foramen, and its head displays the pyriform pattern so characteristic of later Edentates. The foot is clearly like that of *Psittacotherium*.

In reviewing the series, therefore, we see a gradual diminution of the incisors, a gradual loss of enamel on the teeth generally, and the production of hypselodont teeth growing from persistent pulps; all of which are features of the later Edentates. The progression is so gradual that the forms enumerated and described seem to have been part of a continuous series culminating in the Ground Sloths of later times. The other points of similarity will be gathered from the facts given in the foregoing pages.

There is another family belonging to the Ganodonta whose position with regard to the Edentata is not so clear. This is the family **Conoryctidae**, of which two genera are known. The earliest of these, from the Lower Puerco, is *Onychodectes*. In *O tissonensis* the skull is long and narrow, thus contrasting with that of the last family. The facial part is also long. The lower jaw is much more slender. The molar formula was complete, but there is some doubt as to the incisors. The molars are tritubercular.

The other known genus is *Conoryctes*. Its skull has a shorter

facial portion, and is thus more like that of Stylinodontidae than that of *Onychodectes*. The dental formula is known, and is complete save for the loss of one incisor above and below, and one premolar above. The relationship of these Ganodonts to any later forms is uncertain; but their skeletal structure is as yet by no means fully known.

CHAPTER IX

UNGULATA—CONDYLARTHRA—AMBLYPODA—ANCYLOPODA—TYPOTHERIA—TOXODONTIA—PROBOSCIDEA—HYRACOIDEA

Order IV. UNGULATA

THE existing members of this order can be readily grouped into the Hyracoidea, Proboscidea, Perissodactyla, and Artiodactyla, each of which divisions has quite the value of an order, and all of which are sharply marked off from each other. But as the discovery of so many fossil forms has to a great extent rendered these demarcations less sharp, it is better to regard all these groups as not more than sub-orders of a larger "Order" Ungulata. Even when this conclusion has been necessarily arrived at from a consideration of the more ancient groups of Ungulate animals, the definition of such an order remains a difficult matter for the systematist. For the earliest of these forms, more particularly the Ancylopoda, the Amblypoda, and the Condylarthra, whose peculiarities will be dealt with at length subsequently, are not by any means easily differentiated from the primitive Carnivorous mammals of that date, the Creodonta; these latter, moreover, fade into the Marsupials through the so-called Sparassodonta of Professor Ameghino. To confine ourselves to the Ungulates, we may perhaps define them as terrestrial animals with hoofs rather than claws or nails, and chiefly, if not entirely, vegetarian in habit. The teeth are bunodont or lophodont, the tendency to the production of the latter type being always marked. The walk, although plantigrade in the older types, becomes more and more digitigrade, except in such survivals from antiquity as *Hyrax*. There is, too, as we pass from the ancient types to the modern, a gradual perfection of the limbs as running

and not climbing or grasping organs; the number of toes becomes reduced, and culminates twice (in the horse and in the Litopterna) in one toe on each foot; at the same time the ulna becomes rudimentary and fuses with the radius, and the fibula in the hind-limb undergoes a like reduction. The clavicle is absent even in some of the oldest types; its presence in *Typotherium*[1] is highly remarkable. The tail too, an organ which is long in some of the early forms, gets short in their modern derivatives.

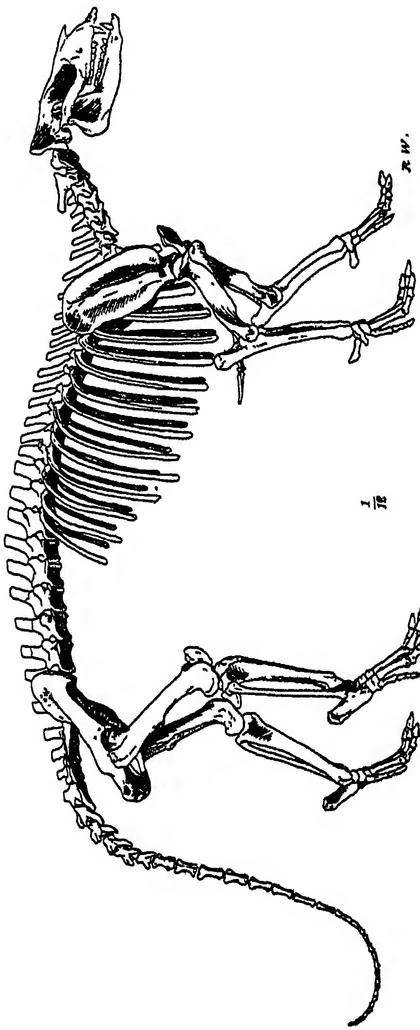

Fig. 110.—An early Ungulate. *Phenacodus primaevus.* × $\frac{1}{12}$. (After Osborn.)

Coupled with the increasing perfection of the foot as an organ used merely for the support of the body, certain interesting changes have taken place in the arrangement with regard to each other of the several bonelets of the wrist and ankle. It has been held by Cope and others that the truly primitive disposition of these bones was that presented to us by certain early types, such as *Meniscotherium* or the existing elephant or *Hyrax*. In these animals there is (see Fig. 112) a serial arrange-

[1] This creature is, however, sometimes referred to the neighbourhood of the Rodents.

ment of these bones, the distal bones only, or very nearly only, articulating with the corresponding bones in the upper series. In the modern types (cf. Fig. 113) there is, on the other hand, an interlocking, so that the bones of the distal series articulate with

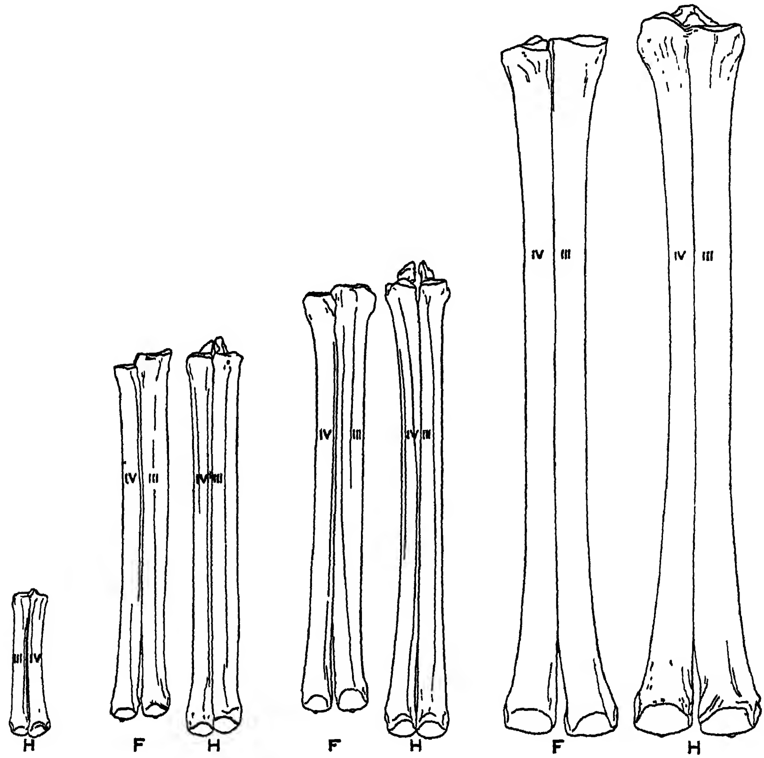

FIG. 111.—Series of metacarpals and metatarsals of Camelidae, to show secular and progressive increase in size. From left to right the species are *Protylopus petersoni*, *Poebrotherium labiatum*, *Gomphotherium sternbergi*, *Procamelus occidentalis*. F, Fore-foot; H, hind-foot; III, IV, third and fourth metapodials (After Wortman.)

two of those of the proximal series. By this is produced, as it would appear, a much firmer foot, less liable to "give" under pressure, and thus more fitted for an animal that runs. It is the same principle as that adopted in the laying of bricks. The actual stress and strain of impact has been held responsible for those changes. An equally ingenious and possibly truer explanation of the undoubted facts has lately been advanced by Mr. W. D.

Matthew.[1] He has pointed out that in some ancient Ungulates the carpus is not serial but interlocking, even in forms which belong to the earliest Eocene groups, such as the genus *Protolambda* among the Amblypoda. Now in the fore-foot of *Meniscotherium* and the living *Hyrax* there is a separate centrale which is wanting in the greater number of Ungulates. The absorption, that is the practical dropping out of this bone, would restore to an interlocking carpus the serial arrangement; while on the other hand, by the

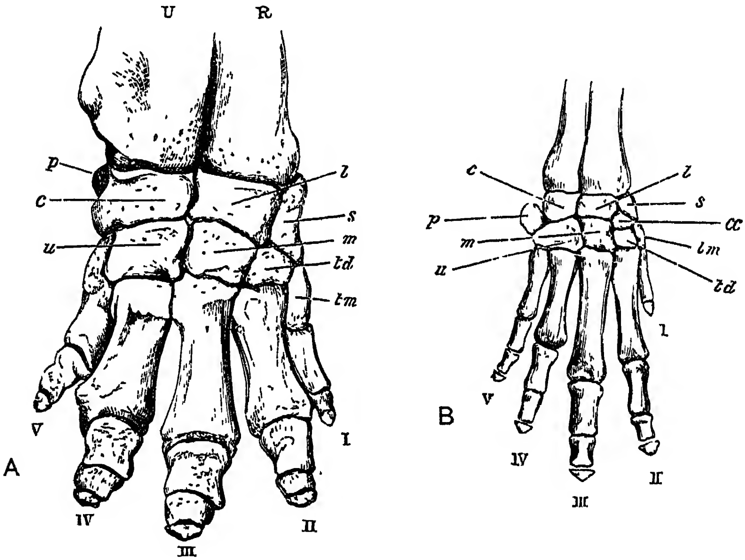

FIG. 112—Bones of the manus **A**, of the Indian Elephant, *Elephas indicus*. × ⅛. **B**, of the Cape Hyrax, *Hyrax capensis*. × 1. *c*, Cuneiform; *cc*, centrale; *l*, lunar; *m*, magnum; *p*, pisiform; *R*, radius; *td*, trapezoid; *tm*, trapezium; *s*, scaphoid; *u*, unciform; *U*, ulna. (From Flower's *Osteology*.)

fusion of this bone with the scaphoid, the interlocking disposition would be maintained.

The gradual perfecting of the fore- and hind-limbs as running organs has been put down to the advent of the grasses, and the formation of large plains covered with this herbage. The same reason would also be in harmony with the equally gradual change in the shape of the molar teeth, from a tubercular form calculated for a mixed or even a carnivorous diet, to the flatter crushing surfaces exhibited by the lophodont teeth of later Ungulates. Strong

[1] *Bull. Amer. Mus. Nat. Hist.* ix 1897, p. 321.

canines would in the same way cease to be useful, and even become encumbrances to such grazing creatures; and their disappearance is one of the salient features in the history of the Ungulata, that is of the modern representatives of the order. The extraordinary hypertrophy of these teeth in such a line as that of the Amblypoda, which has left no descendants, was one of the reasons perhaps for the decay of those great pachyderms of mid-Tertiary times; their excessive armature became an encumbrance, since it was not accompanied by improvements in other necessary

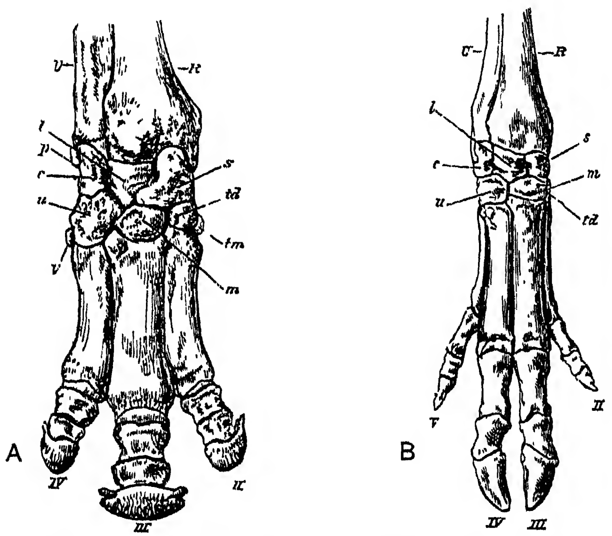

FIG. 113.—Bones of the manus A, of Rhinoceros, *Rhinoceros sumatrensis*. $\times \frac{1}{6}$. B, of Pig, *Sus scrofa*. $\times \frac{1}{3}$. Letters as in Fig. 112. (From Flower's *Osteology*.)

directions. Some of the features of the Tertiary Ungulates have, however, been dealt with in our general sketch of the mammalian life during that epoch, and need not be again referred to here. Of existing Ungulates there are no clear indications of the descent of the Elephants or of the Hyracoidea. Their structure proclaims these two divisions to be of ancient descent, and not to be modern twigs of the Ungulate stem. As to the Perissodactyla and the Artiodactyla we cannot bring them together nearer than in quite early Tertiary times. The order Condylarthra seems to be the starting-point of both these sub-divisions. *Euprotogonia* has been considered to be an ancestor of the Perissodactyle branch, and *Protogonodon* or *Protoselene* of the Artiodactyla. If this be true,

the likenesses which *Titanotherium* shows to the Artiodactyla must be either purely superficial and secondary, or a cropping out of ancient characters which had been dormant for many generations.

Horns.—The Ungulata are the only order of mammals which possess horns; as they are on the whole a more defenceless group than the Carnivora, it may be that the horns are a counterpoise to the teeth and claws of the latter; need for defence and for armature in the combats with their own kind for the favours of the does has led to a different kind of protective and aggressive mechanism. Horns as weapons are, however, particularly effective in this group wherever they exist. A Ruminant is most frequently a large and heavy animal without the agility and litheness of the Carnivore. It is precisely to this sort of animal, where weight is an important consideration, that horns are the most suitable weapons. This is further shown by the fact that although the general term horn is used to describe the weapons of the Ungulate mammals, there is more than one kind of structure included under this general term; it is indeed probable that the extreme terms in the series of horns have been independently acquired by their possessors. There is but little in common between the horns of a Giraffe and of a Rhinoceros. In the Rhinoceros we have one or two horns, in the latter case one placed behind the other, which are purely epidermic growths; they may indeed be regarded as matted masses of hair, borne, it is true, upon a boss of bone, which however is not a separate structure. The Giraffe supplies us with the simplest term in that series of horns which are partly epidermal and partly bony. The paired horns of this animal have often been contrasted with those of the Deer, for example; but there is no fundamental difference between them. In the Giraffe a pair of bony outgrowths, originally separate from the skull which bears them, but ultimately ankylosed to it, are covered by a layer of entirely unmodified skin. A distinction of undoubtedly practical importance is usually drawn between the Hollow-horned Ruminants, *i.e.* Oxen, Goats and Antelopes, and the Deer tribe. There is nevertheless no fundamental distinction. In the Antelopes there is a core of bone, the "os cornu" as it has been termed, which is covered by a horny layer, the horn proper, variously modified in shape and size according to the genus or species. In the Deer there is the

same os cornu, which may however be branched, but which is in the same way covered by a layer of modified integument; this is known as the "velvet"; it only lasts for a certain period, and is then torn off by the exertions of the animal itself, leaving behind the bony core, which is popularly termed the horn It will be clear that here is only a difference of comparative unimportance; the same essential features are present in both groups of animals, but the modification of the epidermis has progressed along different lines. Both can be referred back to the primitive conditions seen in the paired horns of the Giraffe. Even the difference, such as it is, is bridged over by the Antelope *Antilocapra*, where the os cornu is bifid and the horn is periodically shed, as is the velvet of the stag; but in the stag the bony part of the horn is also shed, a state of affairs which has no parallel in the Hollow-horned Ruminants. The great *Sivatherium* may conceivably be an annectant form between the two types of compound horns, *i e.* those of the Antelope and those of the Deer. This creature had two pairs of horns, of which, naturally, only the bony cores remain; the hinder pair of these were branched. But although so far they resemble the Deer's horns rather than the Antelope's, Dr Murie has thought that they were covered by a horny sheath and not by soft skin as in the Deer. In any case these horns were apparently never shed, which is a point of likeness with the Antelope and of difference from the Deer. Apart therefore from the nature of the covering of the bony cores, there are good grounds for looking upon them as intermediate between those of the Deer and those of the Antelopes.

The horns of the Ruminants are frequently a secondary sexual character, this is especially the case with the Deer. The Reindeer is, however, an exception, both the stags and the does having horns. That they are associated with the reproductive function is shown by their being shed after the period of rut, the destruction of the velvet at that period, and also by the effect upon the horns which any injury to the reproductive glands produces Some useful facts upon this latter head have been amassed by Dr. G. H. Fowler,[1] who noticed in a series of stags, horns showing various degrees of degeneration in the antlers produced by varying degrees and periods of gelding. From the facts

[1] "Notes on some Specimens of Antlers of the Fallow Deer, etc.," *Proc. Zool. Soc.* 1894, p. 485.

here collected it is clear that a direct effect is produced. If we are to regard horns as secondary sexual appendages which have been subsequently handed on to the female by heredity, we should expect to meet with examples of animals now horned in both sexes, of which the earlier representatives had the horns confined to one sex. This is most interestingly shown by the extinct and Miocene Giraffe, *Samotherium*, of which the male alone had a pair of short horns, while the skull of the female was entirely hornless, the modern *Giraffa*, as is well known, has horns in both sexes.

It is interesting to note that the existing Perissodactyles and Artiodactyles are to be distinguished by their unpaired or paired horns. But while there are no Artiodactyles with unpaired horns (save occasional sports) the Perissodactyles have more than once tried, so to speak, paired horns, which ultimately proved fatal to them. The Rhinoceros *Diceratherium* apparently inherited and improved upon the small paired horns of *Aceratherium*, but it has left no descendant. The paired horned Titanotheria offer another instance of the same apparent incompatibility between the Perissodactyle structure and the persistence of paired horns.

Sub-Order 1. CONDYLARTHRA.

This group is characterised by the following assemblage of characters. Extinct, often plantigrade Ungulates, with five-toed limbs. Bones of carpus and tarsus not always interlocking, but sometimes lying above each other in corresponding positions. The humerus has an entepicondylar foramen. Dental formula quite complete; the molars brachyodont and bunodont. The premolars are simpler than the molars. The canines are small. As with other early types, the zygapophyses are flat and do not interlock. The astragalus is like that of the Creodonta. This group was American and European in range, the remains of its rather numerous genera being of Eocene time. The best-known genus is *Phenacodus*, of which some account will be given before discussing the, in many cases, more fragmentary remains of other allied forms.

The genus *Phenacodus* was first described so long ago as 1872, from a few scattered teeth. Since then several nearly complete skeletons have been obtained, and we are in full possession of

the details of its osteology. It was not a large creature (see Fig. 110, p. 196), about 6 feet in length, with a small head. The feet were more or less plantigrade, and five-toed. The last phalanges of the toes show that they carried hoofs and not claws, yet the fore-feet look a little as if they could be used as grasping organs. The third digit of both hind- and fore-feet exceeds the others, and thus a Perissodactyle-like foot characterised this Eocene creature. The tail is exceedingly long, and must have reached the ground as the animal walked. This is of course by no means an Ungulate character. Still, in the totality of its organisation the animal was decidedly Ungulate, though Professor Cope spoke of *Phenacodus* as not merely an ancestral Ungulate but as the parent form of Insectivores, Carnivores, Lemurs, Monkeys, and Man himself! The scapula indeed is from its breadth and oval contour rather like that of a Carnivore. The clavicles as in other Ungulates are absent. The femur is Perissodactyle rather than Artiodactyle in the presence of a third trochanter. The creature had fifteen pairs of ribs and five or six lumbar vertebrae. The two bones of the leg which lie below the femur are perfectly distinct and separate. A cast of the brain-case shows that the cerebral hemispheres were smooth and small, the cerebellum of course completely uncovered and nearly as large as the cerebrum. The olfactory lobes were also large. The complete skeleton of *Phenacodus* has lately been excavated more fully from the enveloping matrix by Professor Osborn,[1] and mounted in what is regarded as the natural position of the beast. It appears that though five-toed it went upon the three middle toes only, and furthermore that of these the middle one was the more prevailing, so that *Phenacodus* was distinctly "Perissodactyle," at least in habit. Moreover its "long hind-quarters, the long powerful tail . . . are reminiscent of Creodont ancestry." The genus was European and American in range.

Meniscotherium (= *Hyracops*[2]) comprises several forms of about the size of a fox; they are both European and American in range. The teeth are more distinctly Ungulate in form than those of *Phenacodus*, with a W-shaped outer wall. The skull is described as possessing "indifferent, primitive characters," permitting a comparison with those of Opossums, Insectivores, and

[1] *Bull. Amer. Mus. Nat. Hist.* x. 1898, p. 159.
[2] Marsh, *Amer. Journ. Sci.* xliii. 1892, p. 447.

Creodonta. It has, as in *Phenacodus,* no orbital ring. The humerus resembles that of a Carnivore rather than that of an Ungulate. The carpus and tarsus are serial. The fibula articulates with both the calcaneum and the astragalus, which is not the case with *Phenacodus.* It is suggested that these animals are ancestral forms of the Chalicotheres. In the brain the hemispheres do not cover the cerebellum.

More primitive apparently than *Phenacodus* was the less-known genus *Euprotogonia,* or *Protogonia* [1] as it has been called. The best-known species is *E. puercensis,* so called from its occurrence in the Puerco beds of the American Eocene. It was a slender, long-limbed creature, smaller than *Phenacodus,* with a long and heavy tail as in that animal. Like *Phenacodus* it was semiplantigrade, and shows more likenesses to the Creodonta. The skull is only known by a part of the lower jaw with teeth, and by the teeth of the upper jaw. The vertebrae are not entirely preserved, but enough remain to show that the animal had a tail of 16 or 17 inches, which is a considerable length when compared to its height, about a foot at the rump. In the fore-limb the most noteworthy point is that the ulna has a convex posterior border as in the Creodonts, the same border in *Phenacodus* being concave. The humerus is slender, with less-marked tuberosities. The fifth digit seems to have been less reduced. The phalanges seem to have borne horny sheaths somewhat intermediate between hoofs and claws. The pelvis is described as being, as is also that of *Phenacodus,* rather like that of the Creodonta. The right hind-limb is known in all its details. It appears that the bones are not serial but interlocking, this, however, on the views with regard to the relations of these two forms of tarsus mentioned on p. 198, does not militate against regarding *Euprotogonia* as the ancestor of the genus *Phenacodus.* The third toe is the pre-eminent one, the animal thus being Perissodactyle. The lateral digits are larger than in *Phenacodus,* and the metatarsals and the phalanges. are slightly curved, which is again a Creodont character as compared to the perfectly straight corresponding bones of *Phenacodus.* It seems evident that this animal is to be looked upon as a more ancient type than *Phenacodus,* even if not as its actual ancestor.

Another group of the Condylarthra contains the genus *Pertipychus* and some others. *Periptychus* has the full dentition

[1] See W. D. Matthew, *Bull. Amer. Mus. Nat. Hist.* ix. 1897, p. 303.

of forty-four teeth, the molars being of course bunodont, with the three chief tubercles most developed. The bones of the tarsus interlock and are not serial, as they are in many other members of the Condylarthra. The astragalus has a shorter neck than in *Meniscotherium*, for example. It has in this a likeness to the same bone in the Amblypoda, to the primitive members of which, such as *Pantolambda*, this animal bears much resemblance. "Astragali and many skeletal bones of *Periptychus rhabdodon* and *Pantolambda bathmodon* are almost indistinguishable," observes Mr. Matthew. The fore-feet of this genus are unknown, but it would seem that it was plantigrade from the evidence of the hind-feet. There are several species of the genus.

Possibly, but not at all certainly, the Mioclaenidae, with the genera *Mioclaenus* and *Protoselene*, are to be referred to this same order of primitive Ungulates. It is only necessary to mention them here, because they show very clearly the primitive form of dentition of these early Eocene mammals. The teeth are quite complete and unbroken by a diastema. The canines are but little pronounced. The molars are not strictly tritubercular, but have a prevailing trituberculy. The nature of the feet is not known. Since the genus *Protoselene*, as its name denotes, shows an indication of a commencing selenodonty, it has been suggested that this group is the stock whence the Artiodactyles have been derived.

In any case, whether the particular comparisons that have been made as to the relationship of various forms of Condylarthra are valid or not, it seems to be plain that this group represents the earliest Ungulate stock, but little differentiated from the contemporaneous Creodonts.

SUB-ORDER 2. AMBLYPODA.

This group of extinct mammals has the following principal characteristics:—

They are large, semiplantigrade Ungulates, of heavy build and apparently elephantine gait. The dentition is for the most part complete as in other ancient groups, and the canines are in the later forms big tusks. The back teeth are brachyodont and ridged (lophodont). Both radius and ulna in the fore-limb, and tibia and fibula in the hind-limb, are well developed. The bones

in the carpus are alternating in position The toes are five in both feet, and are very short. There is a hint of commencing "perissodactylism" in the fore-feet at any rate. The brain is small and the hemispheres smooth.

The Amblypoda, or Amblydactyla, are so called on account of their short and stumpy feet and toes. They were held by Professor Cope to be on the direct line of ancestry of both Perissodactyles and Artiodactyles, a view which is on the whole not accepted at present.

As is the case with other groups, the Amblypoda commenced existence as a sub-order with relatively small forms such as

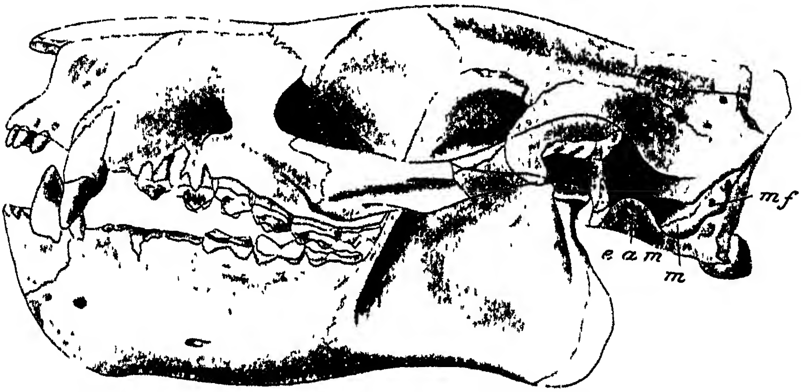

FIG. 114.—Skull of *Protolambda bathmodon*. × ⅔. *e.a.m*, External auditory meatus; *m*, mastoid; *m.f*, mastoid foramen. (After Osborn.)

Pantolambda, the most ancient type known, which is in many respects a transition between the later forms and other groups of mammals such as the Creodonta.[1] The race culminated and ended in the giant *Dinoceras* and *Coryphodon*, and spread into the Old World. In spite of their smooth and diminutive brain, these mammals were able to hold their own and to multiply into many species and genera; in this they were perhaps aided by their formidable tusks and by the horns which many of them possessed. The teeth seem to imply an omnivorous diet, which was quite possibly an additional advantage in the struggle for existence. It does not seem to be necessary to divide off the Dinoceratidae into a sub-order equivalent to the Coryphodontidae as was done

[1] Or perhaps rather to the primitive Ungulates Condylarthra. It is especially compared with *Periptychus* of that group.

by Professor Marsh; the numerous points in common possessed by the members of both families forbid their separation more widely than as families.

The earliest types of Amblypoda belong to the genus *Pantolambda*, of which the species *P. bathmodon* was about four feet in length. As restored it seems to have had proportionately short fore- and hind-limbs, and it had a long tail. It was apparently plantigrade, and would have had not a little likeness to a carnivorous type. The skull has no air cavities, such as are developed in the later types from the Lower Eocene, e.g. *Coryphodon; Pantolambda* is from the basal Eocene. The frontal bones show no trace of the horns that are developed in subsequent forms; the nasals are comparatively long; the zygomatic arch is slender. The molar teeth are in the primitive form of trituberculy, and the premolars, as is so often the case with primitive animals, are unlike the molars in form, being less markedly selenodont. As to the vertebral column, the dorsal vertebrae appear to have had short spines, which argues, as it does also in the case of the larger and heavier *Coryphodon*, a feebleness in the development of ligaments and muscles supporting and moving the head. The scapula seems to have the same peculiar leaf-like form that it has in the later *Coryphodon*.[1] This primitive type shows an entepicondylar foramen in the humerus. It is interesting to observe that the posterior border of the ulna is convex, as in the Creodonts, and in the early Condylarthrous form *Euprotogonia*. In the subsequently-developed Amblypoda, as in the later Condylarthra, that bone acquires a concave outer border. In the carpus the os centrale is distinct. In the femur the third trochanter is well formed; it gradually dies out in later Amblypoda. The fibula articulates with the calcaneum. This species, according to Osborn, "typifies the hypothetical Protungulate, being more primitive than either *Euprotogonia* or *Phenacodus*."[2]

The genus *Coryphodon* is known by a large number of species, of which the first was discovered in this country, and was represented merely by a jaw with some teeth. This was named by Sir R. Owen *C. eocaenus*, and was dredged up from the bottom of the sea off the Essex coast. A second specimen consisted of a single

[1] The scapula of *P. bathmodon* is unknown.

[2] For the structure of this genus and of *Coryphodon*, see Osborn, *Bull. Amer. Mus Nat. Hist.* x. 1898, p. 169.

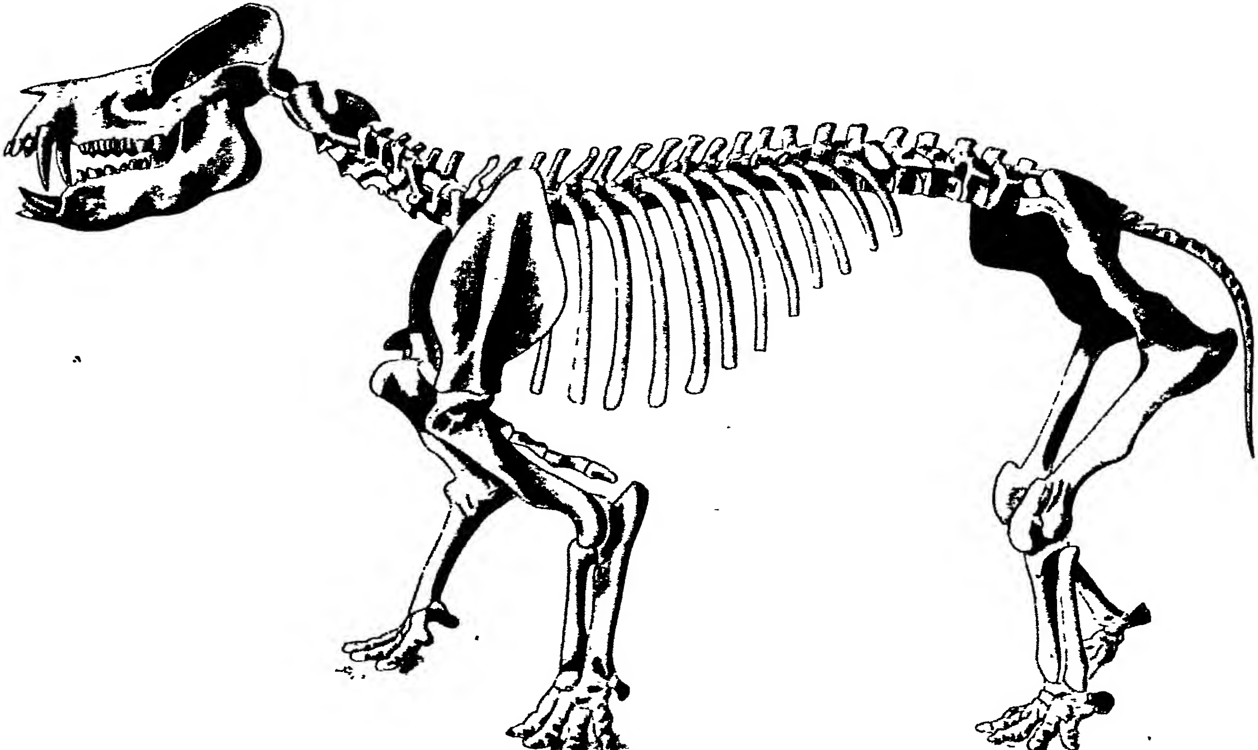

Fig. 115.—Skeleton of *Coryphodon radians.* $\times \frac{1}{10}$. (After Osborn.)

canine tooth only, and was brought up from a depth of 160 feet during the making of a well at Camberwell. More abundant remains have since been found in North America.

This genus had a large head, and in some specimens traces of the "horn cores," so marked in the related *Dinoceras*, are to be noticed. The skull is broad behind and narrowed in front; the roofing bones show the cellular spaces so characteristic of the Elephant. The jugal bone, however, is not, as it is in the Elephant, placed in the middle of the somewhat massive zygomatic arch. As in some other primitive Ungulates (e.g. *Phenacodus*) there are twenty dorso-lumbar vertebrae, of which fifteen bore ribs.

The scapula seems to have possessed a peculiar leaf-like form, swelling in the middle and ending almost in a point above. It has a well-marked spine, and the acromion projects much. The fore- as well as the hind-feet are in a state of transition between plantigradism and digitigradism. It was at one time held that the animal was digitigrade as to the fore-feet and plantigrade as to the hind-feet. Though, as has been pointed out, it is a fact that the hind-feet are often on a different plane of evolution from the fore-feet, it seems that this amount of difference does not characterise any Ungulate, not excepting the genus now under consideration.

The toes are very spreading. The pelvic girdle is of great strength and broadness. The femur, as in the Perissodactyles, has a well-developed third trochanter; but whereas in this particular the hind-limb is Perissodactyle, it is Artiodactyle in the fact that the tibia and the fibula articulate with the astragalus and calcaneum. The ridged teeth have given the name to the genus.

A curious feature in the structure of the genus are the slender spines of the dorsal vertebrae, which contrast with the enormous ones of some other Ungulates—more curious in this genus, which is of heavy build, than in the lighter *Pantolambda*. The back of the animal is short, and the limbs are very spreading, so that the gait was doubtless shuffling. The large head, and short and heavy limbs and limb girdles added probably to its cumbrous walk or trot. The canines are great tusks, and spread out on both sides of the mouth.[1]

The late Professor Cope, in 1874, described the probable appearance of the *Coryphodon* in the following words:—"The general appearance of the Coryphodons, as determined by the skeleton

[1] Osborn, *Bull. Amer. Mus. Nat. Hist.* x. 1898, p. 81.

probably resembled the bears more than any living animals, with the important exception that in their feet they were much like the elephant. To the general proportions of the bears must be added the tail of medium length. Whether they were covered with hair or not is of course uncertain. Of their nearest living allies, the elephants, some were hairy and others naked. . The movements of the Coryphodons doubtless resembled those of the elephant in its shuffling and ambling gait, and may have been even more awkward from the inflexibility of the ankle."

The most recent members of this sub-order come from the Middle Eocene beds, and are chiefly referable to the genus *Dinoceras*, with which *Tinoceras* and *Uintatherium* are at least very nearly related, if not identical. These creatures were of great size, larger than the earlier types which have been considered. They show a certain superficial resemblance to the Titanotheriidae, on account of the massive horn cores upon the skull. These horn cores are large upon the maxillae and the parietals, and are paired; on the nasals are smaller horns. The bones of the skull have air cavities. The incisors of the upper jaw are absent; the canines are enormous tusks, and the lower jaws are flanged downwards near the symphysis where these tusks border them. Contrary to what is found in the older types, where the position of the condyle of the lower jaw is normal, this prominence faces backwards in the Dinocerata. The same shortness of the spines of the dorsal vertebrae prevails in this group as in the other Amblypoda, though it is perhaps hardly so marked. The scapula has not the peculiar acuminate form that exists in *Coryphodon*, but is triangular and broad above. The limbs are elephantine, in that the angle between the humerus and the femur respectively, and the bones which follow, is not marked. The hind-limbs are especially straight. The tail is short as compared with that of the primitive Amblypoda. The Dinocerata are purely digitigrade. The entepicondylar foramen has, as in the Coryphodonts, disappeared. The os centrale of the carpus has become fused, and no longer exists as a separate bone. The fibula no longer articulates with the calcaneum, but both that bone and the ulna are well developed. The genus *Astrapotherium* is placed among the Amblypoda by some authorities[1]

[1] Gadow, *A Classification of Vertebrata, Recent and Extinct*, London, 1898.

SUB-ORDER 3. ANCYLOPODA.

The history of the discovery of the members of this order is very instructive as illustrating the dangers of laying too much classificatory importance upon detached fragments of animals. So long ago as 1825 terminal phalanges of a new creature were found in the Miocene of Eppelsheim, and sent to Cuvier. Cuvier named them "Pangolin gigantesque," deeming them, on account of their general form and cleft terminations, to pertain to the Edentata. In the same bed some seven years later were found certain teeth clearly of an Ungulate character, to which the generic name of *Chalicotherium* was applied. It was subsequently discovered that the teeth and the claws belonged to the same animal, and, later, further remains turned up which disclosed a creature having the anomalous composition of an Ungulate with decisively Ungulate teeth, but with the feet to a large extent like those of an unguiculate animal. The same confusion of characters occurs also, it will be remembered, in the distinctly Artiodactyle *Agriochoerus* (see p. 331). Indeed the feet of the latter when first discovered were erroneously, as it now appears, referred to the present order of Ungulates under the name of *Artionyx*. It is probable that the genus *Moropus* of North America is a member of this group, and that it is probably congeneric with a somewhat different type of Ancylopod known as *Macrotherium*. It is also clear that *Anisodon*, *Schizotherium*, and *Ancylotherium*, if not congeneric with either of the two recognised genera, are at least very close to them.

Chalicotherium has a skull which recalls that of some of the earlier Ungulates; it has, however, no incisors at all, and no canines in the upper jaw; this feature has led to the belief that the animal is related to the Edentata, and that it is in fact a link between them and the Ungulata. The molars, like those of the Perissodactyla, are of the buno-selenodont type. It also agrees with that group (to which it has been approximated by several writers) in the tridactyl manus and pes, and in the characters of the tarsus. But although tridactyl, the axis of the limb passes through the fourth digit. *Chalicotherium* is not mesaxonic, as are the Perissodactyles. Moreover, it has no third

trochanter, and the unguiculate claws have already been referred to. As to the latter, which are short, it is not the end phalanx but the first which is retracted; thus *Chalicotherium* differs markedly from both Carnivorous and Edentate types; for in the former it is the last phalanx which is retracted, while in the Edentates the same phalanx is flexed downwards. The limbs of *Chalicotherium* are nearly of the same size, and the animal seems to have been stout and quadrupedal.[1]

Macrotherium, like the last genus, seems to have been common to both New and Old Worlds. It is to be distinguished by a number of characters. It is supposed to have been "semi-arboreal and fossorial"; the fore-limbs are much longer than the hind, the relative proportions of the radius and tibia being 70 to 29. The ulna was distinct from the radius, whereas in *Chalicotherium* the two are coalesced, or nearly so. Young specimens appear to possess a full set of incisors; whether this is the case or not with *Chalicotherium* is not known.[2]

Homalodontotherium is sometimes placed in the group.

Sub-Order 4. TYPOTHERIA.

It is a little difficult to be confident that the Typotheria are rightly referred to the Ungulata, since they contradict two important Ungulate rules. They have clavicles, which are elsewhere missing, and the thumb looks as if it were opposable.[3] An Ungulate is essentially a running animal, and has no need of a grasping finger. Still Typotheria are placed by most within the Ungulate series, though their undoubted likenesses to other groups, especially to the Rodentia, are admitted, and indeed emphasised. Cope places them definitely with the Toxodonts.

The Typotheria are an extinct group of smallish beasts, confined, like the Toxodontia, to South America, a region which during the Tertiary period, and into the Pleistocene, abounded with strange and varied types of Ungulate animals.

The earlier forms of Typotheria may be exemplified by some

[1] See Osborn, *American Naturalist*, February 1893, p. 118.

[2] It is not absolutely clear whether both or only one genus ranged into America. Different opinions have been expressed.

[3] It must be remembered, however, that there is a suggestion of a prehensile character in the hand of *Phenacodus* (see p. 203).

account of the genus *Protypotherium*. This animal was of about the size of a *Hyrax*, which indeed it resembles in several points of structure. The teeth have the primitive number of forty-four, and they are close set, leaving no diastema; the molars are rootless and grow persistently; they are simple and Rodent-like in surface pattern. The shape of the lower jaw is like that of *Hyrax*, being rounded in outline posteriorly; there is no projecting angle as in the Rodents, and this remark applies to the Typotheria in general. The aspect of the Rodent lower jaw is characteristically different from that of *Hyrax* and the forms under consideration.

Some other characters of these early forms of Typotheria can be gathered from an inspection of other genera. In *Icochilus* both hand and foot were five-toed, and, as in ancient Ungulates generally, the bones of the wrist and of the ankle are serially and not alternately arranged. Moreover, an os centrale is present in the carpus. Both thumb and big toe were opposable. The skull has a remarkably Rodent-like appearance, but the palate is not so narrowed as in these animals.

In the more recent forms of Typotheria the dentition has become reduced. The canines are lost, and as the incisors are reduced also, to one on each side of the upper, and two on each side of the lower jaw, the likeness to a Rodent skull is increased. There is also evidence of a modification from the more primitive forms in the loss of one premolar or even more, in the alternating bones of the carpus, in the disappearance of the centrale, and in the loss of a toe upon the hind-foot. In these more recent forms the fibula articulates with the astragalus instead of with the calcaneum. Typotheria of these more recent forms may be illustrated by the typical genus *Typotherium*. It has the reduced dental formula I $\frac{1}{2}$ C $\frac{0}{0}$ Pm $\frac{2}{1}$ M $\frac{3}{3}$, the molars are simple in pattern, and much like those of *Toxodon* The upper incisors are powerful and curved, but are surrounded by a layer of enamel, which is not limited to the anterior face, as it practically is in Rodents. The sacrum is composed of a large number of vertebrae—some seven—a state of affairs which recalls the Edentata. The shoulder blade is not Ungulate in form. It has a strong spine, with an acromion and a well-developed metacromion. The terminal phalanges are enlarged and hoof-like.

In the genus *Pachyrucos* there are three premolars, otherwise

the formula is the same as in *Typotherium*. The animal seems to have had nails rather than hoofs. The thumb was opposable. The fibula is fused below with the tibia, whereas in the last genus these two bones are quite separate from each other.

SUB-ORDER 5. TOXODONTIA

The group Toxodontia,[1] like so many others, is exceedingly hard to define. Nor are its limits any easier to mark out than many others of the groups of Ungulates. It will be best perhaps to give an account of *Toxodon*, and of a few types which seem to lie near it in the system, and then to indicate how far they resemble or depart in structure from other Ungulates. *Toxodon* itself is known from complete skeletons. It lived in Argentina during the "Pampean" period, which seems to be of the Pleistocene age. A large number of species, however, have been described, some of which seem to go farther back in time, and to have existed during the Miocene period further south in Patagonia.

The size of this creature was about that of a large Rhinoceros; it has a bulky body and a large head, which was borne low down, on account of the bending downwards of the anterior vertebrae, in this aspect the figures of the skeletons recall *Glyptodon* and similar Edentates. The beast was discovered by Darwin, and originally described by Owen. "During his (Mr Darwin's) sojourn in Banda Oriental," writes the Rev. H. Hutchinson, "having heard of some 'giants' bones' at a farm-house on the Sarandis, a small stream entering the Rio Negro, he rode there, and purchased for the sum of eighteenpence the skull which has been described by Sir R. Owen. The people at the farm-house told Mr. Darwin that the remains were exposed by a flood having washed down part of a bank of earth. When found, the head was quite perfect, but the boys knocked the teeth out with stones, and then set up the head as a mark to throw at." The whole of the Pampean area is a valley of dry bones, and the remains of *Toxodon* are abundant there. The skull of *Toxodon* is not unlike that of a horse in general aspect; but the orbit is not separated from the temporal fossa. The premaxillae are furnished above with a slight protuberance directed towards

[1] Cope, *American Naturalist*, xxxi. 1897, p. 485.

the free end of the nasals, which may be related to the presence of a short proboscis. The zygomatic arch is strong and broad; the mandibles are provided with a long symphysis. The dental formula is I $\frac{2}{3}$ C $\frac{0-1}{1}$ Pm $\frac{3-4}{3-4}$ M $\frac{3}{3}$. The teeth are prismatic and hypselodont, growing from persistent pulps. The molar teeth are slightly arched in form, whence the name of *Toxodon*, "bow teeth." The strong chisel-shaped incisors suggest the Rodents and *Hyrax*. The cheek teeth, moreover, are by no means unlike those of Rodents in their pattern. They are at any rate not at all like those of existing Ungulates. The small size of the canine and of the first premolar produces a diastema in the tooth series. The sacrum consists of five vertebrae, and the ischium does not articulate with it.

The shoulder blade has a strong spine, but only a rudimentary acromion; nor is the coracoid well developed. The radius crosses the ulna, as in the Elephant, the whole fore-limb is shorter than the hind-limb, which must have exaggerated the hang-dog expression of the creature when alive. The elements of the carpus interlock in the modern fashion. Those of the tarsus, however, are primitive in lying below each other without alternation. The carpus has a centrale. The fibula articulates with the calcaneum. The femur has no third trochanter. There are three toes to all the limbs. It is clear that this assemblage of characters will not allow the placing of *Toxodon* in any living Ungulate order. If the middle toes appear by their slight pre-eminence to approach the Perissodactyle form, the peculiar surface contour of the molar teeth, letting alone the absence of a third trochanter on the femur, will not permit this classification.

Allied to *Toxodon* is the genus *Nesodon*. It was so named from an "island lobe" on the inner side of the upper molars. This creature, smaller than *Toxodon*, also differs from it in the fact that the dentition is complete, and in the pattern of the molars, which is rather more complex. There is still the slight projection upon the premaxillary bones, but the nostril is directed more forwards than in *Toxodon*. The zygoma, too, is massive. The second pair of incisors in the upper jaw and the outer (third) pair in the lower jaw form biggish tusks in the adult. These and the molar teeth are, however, finally rooted, and do not grow, as in *Toxodon*, from persistent pulps. The genus is from the older Tertiary of Patagonia. Five or six species have been described. Some are as large as a Rhinoceros, others as small as a Sheep.

There is no doubt about the close alliance of the two genera just referred to. It is more doubtful whether *Homalodontotherium* and its allies should be placed, as they often are, in the neighbourhood of the Toxodonts. *Homalodontotherium* owes its name to its even row of teeth without a diastema. It was a creature of equally large size with *Toxodon*, and also came from the Tertiary strata of Patagonia The teeth are the typical forty-four, and the molars like those of a Rhinoceros; they are, however, brachyodont and not hypselodont as in *Toxodon*. This genus, however, shows an important difference from the Rhinocerotidae and from the other Toxodontia in the fact that it was five-toed, and that the bones of the carpus and tarsus are set in relation to each other in the linear serial fashion.

Undoubtedly a near relative of *Homalodontotherium* is *Astrapotherium*. This creature was of equal bulk, and was also Patagonian in range. The teeth are reduced in number, but the animal was provided, like a Wild Boar, with great tusks, which were, however, formed by the incisors. This animal is very imperfectly known: it is the form of the molars and the large size of the incisors which have led to its association with the Toxodontia. As to the resemblance of the teeth of this genus and of *Homalodontotherium* to those of *Rhinoceros*, it is difficult to regard it as evidence of near affinity. The likeness is probably to be looked upon as a case of parallelism in development. Exactly the same explanation is possibly to be given to the likeness which the teeth of *Toxodon* and *Nesodon* show to Rodents, or even to Edentates. As to their affinities Zittel observes:—

"The entirety of their osteological characters argues for the Toxodon a separate position in the neighbourhood of the Perissodactyla, Proboscidea, Typotheria, and Hyracoidea. The relations to the Rodentia rest mainly upon the converging development of the teeth, not upon true relationship."

SUB-ORDER 6. PROBOSCIDEA.

Large vegetable-feeding animals, usually scantily covered with hair, and with the nostrils and upper lip drawn out into a long proboscis. Digits five on both limbs. Femur and humerus not bent upon lower leg and fore-arm in a position of rest. Skull

with abundant air cavities in the roofing and other bones. The incisors are developed into long tusks, which exist in the upper jaw alone, in the lower jaw alone, or in both jaws. There are no canines. The molars are lophodont. The clavicle is absent. The femur has no third trochanter. The bones of the carpus are serially arranged and do not interlock. The stomach is simple. The brain has much convoluted cerebral hemispheres, but the cerebellum is completely uncovered by them. The intestine is provided with a wide caecum. The testes are abdominal. The teats are pectoral in position. The placenta is non-deciduate and zonary. There are two venae cavae superiores.

The position of the limbs in the Elephant tribe is unique among living animals: their straightness that is to say, and the absence or very slight development of angulation at the joints of the limb bones. This same feature has been observed in the extinct Dinocerata and in the Titanotheria. It must not, however, be assumed from the resemblance to these ancient forms that there is much affinity between them and the Proboscidea, or that the latter have retained an ancient feature of organisation. The oldest Ungulates for the most part, and the Creodonts to which they are undoubtedly related, have much bent limbs. It must be considered, therefore, that the arrangement obtaining in the Elephants is purely secondary. Professor Osborn has put forward the reasonable view[1] that the vertical limbs of all these colossal creatures are due to "an adaptation designed to transmit the increasing weight" of these animals. The huge bulk of the body is better borne by vertical pillars than by an angulated limb. Other points, however, such as the exposure of the cerebellum, the two venae cavae, the five digits, and the absence of a third trochanter, argue a low position for the Proboscidea in the Eutherian group.

The group can be readily divided into two families, the Elephantidae and the Dinotheriidae. We will commence with the former.

The Elephants proper, **Elephantidae**, differ from the Dinotheriidae in, and are characterised by, a number of anatomical features. They possess long tusks (incisors) either in both jaws, or, if only in one jaw, in the upper. The molar teeth are very large—so large that only a few of them are simultaneously in use. There are but three definable genera of Elephantidae, of which

[1] *American Nat.* February 1900, p. 89.

Elephas alone survives. This genus also includes many extinct forms, both American and European, as well as Asiatic and African. The entirely extinct genera are *Stegodon* and *Mastodon*. The group is clearly one dwindling towards extermination. From the Middle Miocene downwards these great "pachyderms" have existed; and from the Miocene up to Pleistocene times they were almost world-wide in range and numerous in species.

The genus *Elephas* comprises usually large, but occasionally (the pygmy Elephant of Malta) quite small forms. The external features of the genus differ slightly in different species, and will therefore be described in relation to those species which we shall notice here. The vertebral formula is C 7, D 19-20, L 3-5, Sa 4-5, Ca 24-30, or even more.

The bodies of the vertebrae are remarkable for their shortness and for the very flattened articular surfaces.

The skull is large and massive. Its large and heavy character is, as has been stated in the definition of the sub-order, due to the

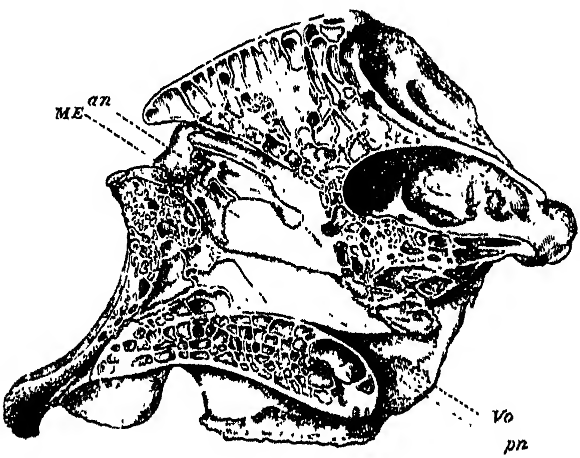

FIG. 116.—A section of the cranium of a full-grown African Elephant, taken to the left of the middle line, and including the vomer (*Vo*) and the mesethmoid (*ME*); *an*, anterior, and *pn*, posterior narial aperture. × $\frac{1}{12}$. (From Flower's *Osteology*.)

immense development of air cavities in the diploe; the diameter of the wall of the skull is actually greater than that of the cranial cavity. These cavities are not obvious in the young animal. They are most conspicuous in the roofing bones of the skull, but are seen elsewhere, and thicken the basis cranii,

the maxillae, and so forth. This state of affairs, together with the presence of the huge tusks, has, as it were, pushed back the nasal orifices to near the top of the skull in a very Whale-like fashion. As in the Cetacea, the nasal bones are limited in size, and the premaxillae send up processes to join the frontals and the nasals. There is a straight and somewhat slender zygomatic arch, but the orbit is not separated from the temporal fossa. The malar bone is small, and, as in Rodents, forms the middle part of the zygoma This is not the case with most Ungulata. The symphysis of the mandibles forms a spout-like rim. The scapula has a narrow prescapular, but a very wide postscapular region The spine has a strong process projecting backwards from near its middle; this is a point of likeness to certain Rodents. No Elephant has a clavicle. The most remarkable feature about the fore-limb is the separation and crossing of the radius and ulna. The arms of these animals are permanently fixed in the position of pronation. The foot is short, and the bones of the carpus are serially arranged. There are, however, traces of a commencing interlocking of these bones in many forms. The hind-feet are somewhat smaller than the fore-feet, and the tibia and fibula are both developed.

As to the teeth, this genus is to be distinguished from allied forms by the presence of tusks in the upper jaw only. These tusks have no bands of enamel such as characterise those of *Mastodon*. They are incisors. There is, however, a trace of the former enamelling in the shape of a patch at the tip, which soon wears away. The molar teeth of *Elephas* are so large that the jaws cannot accommodate more than at the most two and a part of a third at a time. These are gradually replaced by others to the number of three, the replacement of teeth suggesting that of the Manatee. Each molar is deeply ridged, the interstices between the ridges being filled up with cement. As the tooth wears away, therefore, the surface continues to be flat. Each ridge consists of a core of dentine surrounded by a coat of enamel. The number of these ridges varies greatly from species to species. The Indian Elephant is one of those which have the greatest number of plates in a single tooth, as many as twenty-seven.[1] Of the six molars which eventu-

[1] It must be borne in mind that the teeth increase in complexity, those first pushed up having the fewest plates. The first has only four transverse plates.

ally appear, the first three are considered to correspond to premolars. But successional teeth are rare in the genus; that is to say as far as concerns the molars, for the tusks have their milk forerunners. As to the molars it is apparently only *E. planifrons* which certainly shows a milk dentition. In *Mastodon* and older types a milk dentition is commoner.

The viscera of the Elephant have been examined by many zoologists. The latest paper, dealing chiefly with the African species, but containing facts about its Indian congener also, is quoted below.[1] The Elephant is remarkable in possessing, in addition to the three usual pairs of salivary glands present in mammals, a fourth, situated in the molar region, and opening on to the cheek by many pores. This gland is especially well developed in Rodents There is a gland which may be mentioned in this connexion, though it opens externally between the eye and ear, known as the temporal gland; its use does not seem clear. The thoracic cavity of the Elephant, as may be inferred from the large number of ribs, is very large as compared with the abdominal.

The stomach is simple in form, and the epithelium of the oesophagus does not extend into it as is the case with the Horse and Rhinoceros. A gland or a collection of smaller glands occurs in the stomach, and recalls the "cardiac gland" of the Wombat and the Beaver, also that of the Giraffe. The large intestine is long, rather more than half the length of the small intestine. The caecum is well developed in these animals. The liver has a very simple form, being but slightly lobulated. It is actually only bilobed, but it is important to notice that this division does not correspond to the two halves of the liver. As shown by the attachment of the suspensory ligament, one half consists of the left lateral lobe alone, the other half embracing the remaining primary lobes. The simplicity of the liver looks like an archaic character. No Elephant has a gall-bladder. The lungs again are simple in form through their slight lobulation. Each half in fact is without subdivisions, and is of a triangular form. In this the Elephants resemble the Whales, as in the simple liver. In both cases probably the likeness is due to the permanence of primitive features of organisation. The brain[2] of the Elephant

[1] Forbes, *Proc. Zool. Soc.* 1879, p 420.

[2] See Krueg, *Zeitschr. wiss. Zool.* xxxiii 1881, p. 652, and Beddard, *Proc. Zool. Soc.* 1893, p. 311.

has hemispheres which are extremely well convoluted; but they leave the cerebellum entirely uncovered. This suggests a brain which is a great specialisation of a low type. The brain has been particularly compared with that of the Carnivora, with which group the Elephants agree in the characters of the placenta. It is, however, always a matter of the very greatest difficulty to compare the brains of mammals belonging to different orders.

There are but two living species of Elephant, of both of which we shall now proceed to give some account. Only a few of the rather numerous fossil forms can be touched upon here.

The African Elephant, *E. africanus*, has been sometimes referred to a distinct genus or sub-genus, *Loxodon*, by reason of the lozenge-shaped areas on the worn grinding-teeth. It lives, as its name denotes, in Africa. This species has a number of external features which enable it to be distinguished from the Oriental Elephant. The head slopes back more, and has not the two rounded bosses which give so wise a countenance to the Indian species. The ears are very much larger. The tip of the trunk has a slight triangular projection on both the lower and the upper part of the circumference of the aperture. There are four nails on the fore-feet and three on the hind. As in the Indian form, the toes are all bound together, and do not appear for any part as free digits. A thick pad of fat, etc., makes the animal when alive look as if plantigrade, whereas it is, as a matter of fact, digitigrade. In internal features the most prominent difference from *E. indicus* is in the molar teeth, which are ridged by much fewer ridges. The outside number for a single tooth in the present species is 10 or 11. In *Elephas indicus* on the other hand there are as many as 27.

The African Elephant, thinks Sir Samuel Baker, reaches a height of about 12 feet, and it will be remembered that the notorious "Jumbo" was found to be 11 feet high at the shoulder. The tusks are found in both sexes, as in the Indian beast, but are relatively larger in the female in the species now under consideration. It is also a rather more active creature, and is more savage;[1] however it can be tamed, as is shown by several

[1] So convinced are some persons of the untameable character of the African Elephant, that it has even been suggested that the animals with which Hannibal crossed the Alps were not *E. africanus*, but a now extinct species!

specimens which have been and are in the possession of the Zoological Society, and other proprietors. It was apparently used in the past. Certain Carthaginian coins are stamped with a figure of

Fig. 117.—African Elephant *Elephas africanus*. $\times \frac{1}{36}$. (After Sir Samuel Baker.)

the African Elephant; but in Africa no attempts are now made to utilise this creature except for food and ivory.

The meaning of an Elephant as an emblem upon a coin appears to be eternity, and there is no question but that the

Elephant is a long-lived animal. It is said that it hardly reaches proper maturity before forty, and that 150 years is not beyond probability in the way of longevity. Even longer periods have been assigned to it.

The tusks of the Elephant are by no means necessarily sexual adornments, used for fighting purposes only. The African Elephant is a most "industrious digger," and grubs up innumerable roots as food. It appears to be a fact that during these operations the right tusk is mainly used, and in consequence that tusk is shorter as well as thinner than the other. Two average tusks would weigh respectively 75 and 65 lbs., the latter of course being the weight of the more worn right tusk These weights, it should be observed, by no means indicate the limits to which finely-developed tusks can attain. The very heaviest tusk known to Sir Samuel Baker[1] weighed 188 lbs. This was sold at an ivory sale in London in the year 1874. The pace of the African Elephant, says the same authority, is at most at the rate of fifteen miles an hour at first, and of course in a furious rush. This pace cannot be kept up for more than two or three hundred yards, after which ten miles an hour is a better approximation to the rate which can be kept up for long distances.

The Indian Elephant, *Elephas indicus* (or *Euelephas indicus*, if the genus *Loxodon* is to be accepted), is better known and has been longer known than the African. It occurs in India and Ceylon, and in some of the Malayan islands, the Elephants of which latter parts of the world have been regarded as a distinct form, an apparently unnecessary procedure.

This species does not stand so high at the shoulder as the African; its back is more rounded in the middle. The trunk has but one pointed tip; there are five nails on the fore- and four on the hind-feet. As this species comes from India and the East, it has been longer as well as better known than the African form. Thus many of the stories and legends that have congregated round Elephants apply really to this form. As is well known, the Indian Elephant is much used as a beast of burden, and for other purposes where its huge strength renders it invaluable. But its great drawback as a servant of man is its great independability. On the one hand we have furious, vicious, and generally unreliable

[1] *Wild Beasts and their Ways*, London, 1890.

Elephants, and on the other perfectly docile creatures, who obey the slightest hint from their driver. Huge though the Elephant

Fig. 118.—Indian Elephant *Elephas indicus.* $\times \frac{1}{34}$ (After Sir Samuel Baker.)

is, it is frequently a timid beast. Sir Samuel Baker relates how one which he was riding fairly bolted at the sight of a Hare. To

be bolted with by an Elephant is far from pleasing, though a rather exciting event. It makes for the nearest jungle at once, being, much more than the African species, an inhabitant of forest. And in rushing through the dense undergrowth, the occupiers of the Elephant's back are apt to be swept off or cut to pieces by innumerable thorns.

Elephants, no doubt of the Indian species, were used by the Persians in battle, and from fifteen which were captured at the battle of Arbela some notes were drawn up by Aristotle. In stating that the animal reaches an age of 200 years, the naturalist and philosopher was probably not very far out. The mode of Elephant-catching as related by Aristotle is that pursued at the present day. Then, as now, tame Elephants were made use of as decoys. Pliny,[1] who was apt to confound fact and fiction in a somewhat inseparable tangle, had something to say about Elephants, both Indian and African. Serpents, he thought, were their chief enemies, which slew them by coiling round them and thrusting their heads into the trunk, and so stopping respiration. In Europe Elephants were first seen in the year B.C. 280. Pyrrhus used them in his invasion, and copying his example the Romans themselves learnt to use Elephants. The first Elephant seen in England arrived in the year 1257, presented by the King of France to Henry III. It was kept in the Tower (for long afterwards a menagerie), and died at twelve years of age. Much use of the Elephant has been made in symbols. We have spoken of the African Elephant on Carthaginian coins as an emblem of eternity. The Oriental Elephant resting on the back of a tortoise and supporting the world is the same idea; and it is instructive to note that remains have been found in the Siwalik Hills of a tortoise which would have been actually big enough to support the creature, even "Jumbo," who weighed 6½ tons. Another symbol is that of an Elephant upon whose back is a child with arrows; this occurs on a medal of the Emperor Philip. It can perhaps hardly signify the eternity of a strong human feeling!

The intelligence of the Elephant has been both exaggerated and minimised. Perhaps the most elaborate attempt to endow the beast with unusual mental perceptions is that of Aelian, who related that an Elephant carefully watching his keeper, wrote after him with his trunk letters upon a board. That the animal does

[1] See *Natural History of the Ancients*, by Rev. M. G. Watkins, London, 1896.

possess a good deal of brains, seems to be shown by the way in which a well-trained animal will obey the slightest sign of the mahout in India. According to Sir Samuel Baker, localities which produce in abundance particular kinds of fruit are remembered, as well as the time at which the fruit will be at its best. Stories of revenge, which are numerous enough, attest, so far as their data are to be accepted as accurate, the power of memory possessed by the Elephant.

In spite of their longevity, however, Elephants, unlike Rome, have not been built for eternity. We can only find two living species; but in past times Elephants were very numerous. They commenced, so far as we know, in the Miocene.

The existing forms are known in a fossil, or at least sub-fossil state, from diluvial deposits; and it is interesting to note that the African Elephant had formerly a wider range than now. Its bones (described as *E. priscus*) have been met with in Spain and Sicily.

One of the best known of completely-extinct Elephants is the Mammoth, *E. primigenius*. This great Elephant in most respects more nearly approached the existing Indian Elephant. The teeth have quite as numerous plates. The tusks were enormous, reaching a maximum length of 15 feet; they were much curved upwards as well as outwards. A large tusk weighs as much as 250 lbs. The Mammoth was of exceedingly wide range. Not only was it found in various parts of Europe, but it was especially abundant in Siberia, as is exemplified by the fact that for the last two hundred years as many or more than 100 pairs of tusks annually have been sold from that region. It also occurred in America together with forms at least not far removed from it, such as *E. columbianus*. Mammoths have been more than once found as entire carcases in the frozen soil of Siberia. The first was discovered in the year 1799, and rescued some years later for the St. Petersburg Museum. This example showed that the Mammoth, unlike existing Elephants, was covered with thick wool mingled with long and more bristly hairs of some 10 inches in length The softer wool formed a kind of mane beneath the neck, which hung down as far as the knees. Another carcase was discovered later by Lieut. Benkendorf, who did not save it, but was nearly swept along with it into the sea by a flood. These creatures died in the position in which they were found by being bogged when in search of vegetation or water.

How primeval man, with his inferior weapons, slew the Mammoth is not easy to understand; but that they were contemporaneous is clearly shown by associated remains, and by the notorious sketch of the Mammoth on a piece of its own ivory, in which curved tusks and a forehead like that of an Indian Elephant are plainly to be seen. Although it was only so recently as the year 1799 that an example of this great creature was actually studied on the spot, and removed to St. Petersburg, the existence of Mammoths and of ivory is a matter of much more ancient knowledge. M. Trouessart relates[1] that fossil ivory was known to the Greeks. Theophrastus spoke of ivory imbedded in the soil, and the tusks were recovered by the Chinese. It is a curious fact that the Chinese described and figured the Mammoth as a kind of gigantic Rat. The likeness between the elephantine molar and that of Rodents has been commented upon; but the existence of its tusks below the level of the ground led the Chinese Natural Historians to consider that the ways of life of the Mammoth were those of the Mole. As to the carcases themselves, the Chinese said that the flesh was cold, but very healthy to eat. This expression can hardly be explained, except upon the view that fresh carcases were known to that people long before they were known to us of the Western world. The value of the Mammoth ivory was known to antiquity; the famous Haroun-al-Raschid gave to King Charlemagne not only a pair of living Elephants, but a "horn of Licorne," which seems undoubtedly to have been a name for the tusks of the Mammoth. For in an account of the sacred treasures of Saint Denis, published in the year 1646, the author states this to be the fact.

The causes of the disappearance of the Mammoth are not easy to understand. Some held that it was a naked animal like the existing Elephants, and that the lowering of the temperature in Siberia proved fatal; it is, of course, now certain that it was clothed with dense woolly hair. Along with the bogged corpses of the great pachyderm, numerous trunks of pine-trees have been found, together with associated remains of other animals now extinct in that neighbourhood. Thus it is plain that Siberia was once covered by mighty forests, through which the Mammoth roamed. The decay of these forests, upon whose branches the Elephant fed, as is attested by the remains of pine leaves found

[1] *Bull. Soc. Nat. d'Acclimat.* xlv. 1898, p. 41.

in the interstices of its teeth, was the signal for the disappearance of their most colossal inhabitant.

The large number of remains of this and of other extinct species of *Elephas* in this country gave rise to the supposition that they were Elephants brought over by Caesar to aid in the subjugation of these islands. The Rev. J. Coleridge (father of the poet) pointed out that though Caesar in his *Commentaries* made no mention of any such importation of Elephants, a passage in the *Stratagems* of Polyaenus expressly mentions that Cassivelaunus was confronted by the Romans with an Elephant clad in a coat of mail, by whose aid the crossing of the Thames was effected. At the time that attention was called to this (1757) it was not popular to hint at the possibility of fossils. So that fact, conveniently historical, served to explain away a difficulty. It is remarkable that the Elephant, common enough of course in Asiatic monuments, actually occurs in English architecture. Mr. Watkins, from whose interesting work (*Natural History of the Ancients*) a good many of the facts detailed here are drawn, tells us that the church of Ottery St. Mary has an Elephant's head sculptured on one of its pillars. The same ornament appears in Gosberton Church, Lincolnshire. Whether this has anything to do with a reminiscence of formerly existing Elephants is a hard question to answer. In this figure of an Elephant the trunk has a spiral representation, and the trunk of an Elephant is believed by some to be intended by the common "so-called Pictish ornamentation" in Scotland; this spiral alone is to be seen constantly. If it is a reduction of an Elephant to its simplest terms, it is highly interesting as an almost undoubted survival of remembrance of Elephants. For at such a period we cannot use the memories of Crusaders or others who may have visited the East to explain the facts. The sculptured Elephants' heads might conceivably be so explained.

The name Mammoth, thinks Mr. Watkins, may be derivable from the Arabic word Behemoth. He quotes a writer, who first described the beast in 1694, as using the two words indifferently The Arabs, moreover, were then as they are now great ivory traders: and in the ninth and the two succeeding centuries explored the confines of Siberia, as they now do the forests of Africa, for ivory. The "Behemoth" of Job "eateth grass as an ox. . . . He moveth his tail like a cedar" (the Hippopotamus has a much more

stumpy appendage). "Behold, he drinketh up a river, and hasteth not" is surely much more suggestive of the copious draughts of an Elephant than the possibly equally copious but not so visible libations of a Hippopotamus.

The most ancient of the true Elephants (genus *Elephas*) is *E. meridionalis*. It is of the African type, *i e.* the plates of the molar teeth are not abundant, and are not so many as in the existing *E. africanus*. It seems to have been one of the largest of Elephants, standing 4 metres high. Its remains are abundant in Europe, and are known also from England. Like this species *E. antiquus* is also of the African type. It was contemporary with man. Certain dwarf or "pony" races found in caves in Malta, and called *Elephas melitensis* or *E falconeri*, are believed to belong to this species. Mr. Leith Adams, who described these[1] remains, placed them in two dwarf species called by the names used above, and found associated with them a larger form, which he referred to *E. antiquus*. The existence of these animals in Malta seems to argue at least its former larger dimensions, and the presence of more abundant fresh water. The remarkable swimming capabilities of the Elephant do not necessarily imply either a former absence of land connexion or, on the other hand, its existence. Nor as a third possibility can it be suggested that the dwarf size argues an island of limited dimensions, when we bear in mind the huge tortoises of the Galapagos and some other islands. It is important to notice that Elephants of the African type (*Loxodon*) were not formerly absent from India. *E. planifrons* was one of these.

The genus *Stegodon* is so called from the fact that the molar teeth, seen in longitudinal section, present a series of roof-shaped folds, the interstices between which are not, or are, imperfectly filled up with the cement which in *Elephas* reduces the surface of the teeth to a level plane. This genus is exclusively Asiatic, and is Miocene to Pleistocene in time range. The number of ridges on the molars is small, not more than two. The incisors (tusks) have no enamel; the skeleton generally is like that of *Elephas*, between which and *Mastodon* the present genus is intermediate. Among the four or five species is *S. ganesa* (called after the Indian Elephant-headed divinity), with tusks 10 feet long, to be seen at the British Museum of Natural History.

[1] *Trans. Zool. Soc.* ix. 1874, p. 1.

The last genus of the family Elephantidae is *Mastodon*, so called from the structure of the molar teeth These are provided with but few transverse ridges, not more than five, so that their structure is intermediate between those of *Dinotherium* and those of *Stegodon*. Between the ridges are sometimes isolated, boss-like protuberances (whence the name of *Mastodon*), produced by a subdivision of the ridges. There is either but little or no cement between the ridges. This genus differs from nearly all other Elephantidae by the possession of milk molars, which occasionally persist throughout life, the permanent dentition in those cases being a mixture of milk and permanent teeth, as has been (erroneously) stated of the Hedgehog.[1]

The tusks (incisors) are sometimes present in both jaws, and as they have, during youth at any rate, a coating of enamel, the likeness to the chisel-shaped incisors of Rodents is patent. In connexion with the implantation of incisors in the lower jaw, many species have a prolongation of the bones of that part of the skeleton. In the bones, generally, there is not very much difference from *Elephas*, but the forehead is a little less pronounced. The genus existed from the Miocene and became extinct in the Pleistocene. It was nearly world-wide in range, being known from all four continents. Naturally with this very wide range was associated a large number of species. Zittel enumerates no less than thirty-two.

This genus is the only one of the Elephantidae which extended its range into South America, where the remains of two species occur. The bones of these great Elephants have attracted attention for some centuries. They were often held to be the bones of giants (as they actually were!), and in one case were ascribed to a deceased monarch, Teutobochus. The American Indians considered that equally gigantic men lived who were able to combat these great Proboscideans. There are legends of the Mastodons as living animals, which is quite probable, considering their geological age. There is a curious parallelism between the legends of two such widely-separated localities as North America and Greece. Buffon relates how among the Indians of Canada there was a belief that the Great Being destroyed both Mastodons and men of equal proportions, with thunderbolts. With this we may perhaps compare the story of the destruction of Typhoeus by Zeus, who

[1] See Busk in *Trans. Zool. Soc.* vi. 1868, p. 227.

also used thunderbolts. One of the giants was not slain, but was compelled to stand and bear up the heavens. Atlas holds thus the position of the Elephant supporting the globe of Indian mythology.

The genus *Dinotherium*, sole representative of the family **Dinotheriidae**, differs in a number of important particulars from the true Elephants. In the Elephants, if there is but a single pair of incisors, these are found in the upper jaw; in *Dino-*

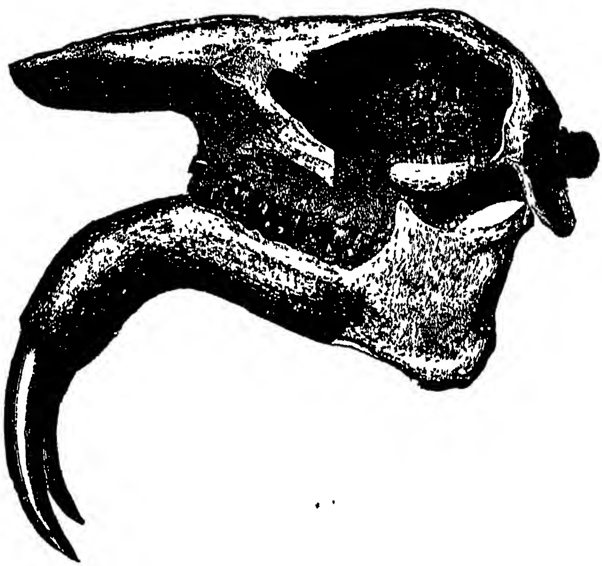

FIG. 119.—*Dinotherium giganteum.* Side view of skull, $\frac{1}{16}$th natural size. Miocene, Germany. (After Kaup.)

therium there is apparently but a single pair, but these are implanted in the lower jaw, the symphysis of which is much prolonged and greatly bent downwards, so that the tusks emerge at right angles to the long axis of the head, and are even bent backwards. The molar teeth are five in number on each side of each jaw and are bi- or tri-lophodont, not unlike those of the Tapir. There is no cement in the valleys between the ridges of these teeth, and there is a regular succession, the premolars being two and the molars three.[1] All the teeth are in use at the same time,

[1] There are, however, three milk forerunners of the premolars, of which one has no successor.

their small size enabling them to be accommodated in the jaw together The skull of *Dinotherium* is lower than that of *Elephas* or *Mastodon* The bones of the skeleton generally are like those of *Elephas*.

Though a suggestion of marsupial bones attached to the pelvis has been discredited, there is no doubt that *Dinotherium* occupies the most primitive position among the Proboscidea; but at the same time it cannot be regarded as the ancestor of Elephants, as it is so much specialised in various ways. The incisors for one thing forbid this way of looking at the creature. It is an ancient genus found in beds of Miocene age in Europe and Asia. It is not known from America. The creature was larger than any Elephant. Eighteen feet in length has been assigned to it. The enormous weight of the lower jaw and tusks seems to argue that it was at least partially aquatic in habit, and that it may have used these tusks for grubbing up aquatic roots or for mooring itself to the bank. At first there were naturalists who considered it as an ally of the Manatee, and the skull is not unsuggestive of that of the Sirenia.

Pyrotherium has been referred to the Proboscidea; but our knowledge of that form is limited to a few teeth from Patagonian rocks of an uncertain age.[1] They are simple bilophodont molars, very like those of *Dinotherium* A tusk has been found in the neighbourhood of these teeth which may possibly belong to the same animal; but it is uncertain.

SUB-ORDER 7. HYRACOIDEA.

This group of small mammals contains only one well-marked genus which is usually named *Hyrax*, although *Procavia* seems to be the accurate term. Popularly these creatures are known as Coneys. They have a singular resemblance to Rodents, the short ears and much reduced tail, besides the squatting attitude adopted, contributing to this merely skin-deep likeness. They agree with other Ungulates in the structure of the molar teeth, which are much like those of *Rhinoceros;* in the absence of a clavicle; in the absence of an acromion; in the reduction of the digits of the limbs to four digits in the manus and three in the pes. On the

[1] Lydekker, *An. Mus. La Plata, Pal. Arg.* iii. 1891.

other hand they differ from most Ungulates in the incisors growing from persistent pulps, a point in which they resemble the Rodentia. The muffle also is split as in those animals. The Hyracoidea are peculiar in the fact that in addition to the caecum at the junction of the small and large intestines, there are a pair of caeca (bird-like in being paired) some way down the large intestine. The dorsal vertebrae are unusually numerous, 22. The adult dentition according to Woodward,[1] who has recently examined the matter, is I $\frac{1}{2}$ C $(\frac{1}{0})$ Pm $\frac{4}{4}$ M $\frac{3}{3}$, while the milk dentition is I $\frac{3}{2}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$.

The inclusion of the canine of the permanent set of teeth in brackets signifies that it is the milk canine which occasionally

FIG. 120.—Cape Hyrax. *Hyrax capensis.* × $\frac{1}{8}$.

persists. It should further be remarked about the teeth that they are both hypselodont and brachyodont, the extremes being connected by intermediate forms. Another peculiarity of the genus is the dorsal gland, which is covered with hair of a different colour to that covering the body generally. This is present in all species.

The genus *Hyrax* (the most recent authority on the subject, Mr. Oldfield Thomas,[2] only allows one genus) is limited in its range to Ethiopian Africa and to Arabia, including Palestine, It does not reach Madagascar Mr. Thomas allows fourteen species with two or three sub-species.

[1] M. F. Woodward "On the Milk Dentition of *Procavia* (*Hyrax*) *capensis*, etc," *Proc. Zool. Soc.* 1892, p 38

[2] "On the Species of the Hyracoidea," *Proc. Zool. Soc.* 1892, p 50.

Some of the Coneys live in rocky ground, while others, formerly placed in the genus *Dendrohyrax*, frequent trees, in holes in which they sleep. The Coney of the Scriptures is familiar, who is "exceeding wise," though a "feeble folk." But the further observation that he "cheweth the cud but divided not the hoof," is obviously entirely wrong. As to the wisdom, it is said that this beast is too wary to be taken in traps; while the suggestion of chewing the cud is, according to Canon Tristram, to be interpreted in the light of a habit of working and moving its jaws which the animal has. The traveller Bruce kept one in captivity to see if it did really chew the cud, and found that it did!

CHAPTER X

UNGULATA (*continued*)—PERISSODACTYLA (ODD-TOED UNGULATES)—LITOPTERNA

SUB-ORDER 8. PERISSODACTYLA

THESE Ungulates derive their name, which is that given by the late

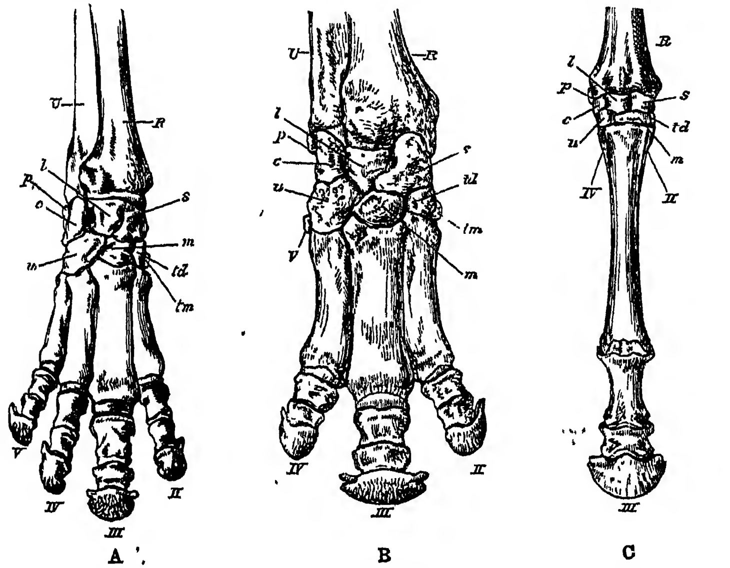

FIG. 121.—Bones of the manus **A**, of Tapir (*Tapirus indicus*). × ⅛. **B**, of Rhinoceros (*Rhinoceros sumatrensis*) × ⅛. **C**, of Horse (*Equus caballus*). × ⅛. *c*, Cuneiform; *l*, lunar; *m*, magnum; *p*, pisiform; *R*, radius; *s*, scaphoid, *td*, trapezoid; *tm*, trapezium; *u*, unciform; *U*, ulna, *II*-*V*, second to fifth digits; *V* in **B**, and *II* and *IV* in **C**, represented by rudimentary metacarpals. (From Flower's *Osteology*.)

Sir Richard Owen, from the fact that the middle digit of the hand and foot is pre-eminent. As will be seen from Fig. 121, the axis of

the limb passes through the third finger, which is larger than any of the others, and is symmetrical in itself. In this the present group contrasts with the Artiodactyla, where the axis is not "mesaxonic," but where there are two digits, on either side of the axis, which are symmetrical with each other This arrangement of the limbs is highly characteristic, but appears to be not quite universal. In the Titanotheres, which form a group of the Perissodactyles, the fore-limbs are not quite accurately mesaxonic. Nor on the other hand can all Ungulates which show the Perissodactyle condition be safely included in the present group. The ancient Condylarthra and the Litopterna show precisely the same state of affairs. But other features in their organisation lead to their separation from the Perissodactyles, of which, however, the Condylarthra are probably ancestors. The Litopterna on the other hand, which possess even one-toed members like *Equus*, are believed to represent a case of parallelism in development. The number of functional toes varies from four to one. In the ankle joint the astragalus either does not, or does only to a comparatively slight extent, articulate with the cuboid as well as with the navicular bone. Moreover the fibula when present does not as a rule articulate with the calcaneum. In the opposed group of Artiodactyles the precise reverse of these conditions obtains. It is usually stated as part of the definition of this group that they do not possess horns of the type of those met with in the Cervicornia and Cavicornia. But the strong bony bosses on the skull of many Titanotheres, so curiously reminiscent of those of the not nearly related *Dinoceras* and *Protoceras*, may well have supported horns of the Ox and Antelope pattern.

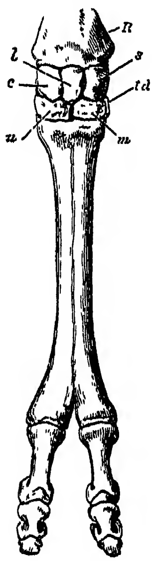

FIG. 122.—Bones of the manus of Camel (*Camelus bactrianus*). × ⅛. *c*, Cuneiform; *l*, lunar; *m*, magnum; *R*, radius; *s*, scaphoid; *td*, trapezoid; *u*, unciform. (From Flower's *Osteology*.)

The teeth of the Perissodactyles are lophodont, more rarely bunodont. The selenodont Artiodactyle form of molar is not met with. The dental formula, moreover, is at least near the

complete one, the more modern forms as usual being the more deficient in numbers of teeth.

The dorso-lumbar vertebrae are as a rule twenty-three; but the extinct Titanotheres are again an exception; for, at least in *Titanotherium*, there are but twenty of these vertebrae—an Artiodactyle character. The femur has a third trochanter. There are so few recent Perissodactyles that an enumeration of the distinguishing characters of the viscera may very probably be useless for purposes of classification. But the living genera at any rate are to be separated from the living Artiodactyles by the invariable simplicity of the stomach coupled with a very large and sacculated caecum. The liver is simple and not much broken up into lobes, and the gall-bladder is always absent. The brain is well convoluted. The teats are in the inguinal region. The placenta in this group is of the diffused kind.

FIG. 123.—Anterior aspect of right femur of Rhinoceros (*Rhinoceros indicus*). × ¼. *h*, Head; *t*, great trochanter; *t'*, third trochanter. (From Flower's *Osteology*.)

The living Perissodactyles belong to three types only, indeed to three genera only (in the estimation of most), which are the Horses, Tapirs, and Rhinoceroses. But taking into account the extinct forms, they may be divided primarily (according to Professor Osborn) into the four following groups:—(1) Titanotherioidea, including but one family, Titanotheriidae; (2) Hippoidea, including the families Equidae and Palaeotheriidae; (3) Tapiroidea, with two families, Tapiridae and Lophiodontidae; and (4) Rhinocerotoidea with families Hyracodontidae, Amynodontidae, and Rhinocerotidae. It is conceivable, according to the same writer, that the Chalicotheres (here treated of as a separate sub-order, Ancylopoda) should be added to the Perissodactyle series.

Fam. 1. Equidae.—This family, which includes the living Horse, Zebras, and Asses, as well as a number of extinct genera agreeing with those types in structure, may be defined by the possession of but one functional toe, the two lateral ones being mere splints, or but little more. The molar teeth are hypselodont, and

the premolars, with the exception of the first, resemble the molars in their pattern. The orbit is completely surrounded by bone. The incisors are chisel-shaped, with a pit on the free surface. The canines are rudimentary if present. The radius and ulna are fused, as are the tibia and fibula. Although for the sake of uniformity a family, Equidae, is here separated from its allies, it is quite impossible owing to the full state of our knowledge of this group to draw a really hard-and-fast line between this family

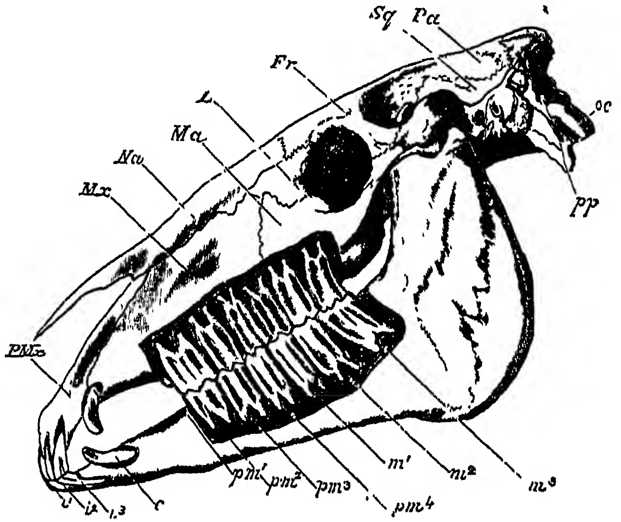

FIG. 124.—Side view of skull of Horse with the bone removed so as to expose the whole of the teeth. *c*, Canine; *Fr*, frontal; i^1, i^2, i^3, incisors; *L*, lachrymal; m^1, m^2, m^3, molars; *Ma*, malar or jugal; *Mx*, maxilla; *Na*, nasal; *oc*, occipital condyle; *Pa*, parietal; pm^1, situation of the vestigial first premolar, which has been lost in the lower, but is present in the upper jaw; pm^2, pm^3, pm^4, remaining premolars; *PMx*, premaxilla; *pp*, paroccipital process; *Sq*, squamosal. (After Flower and Lydekker.)

and the Palaeotheriidae. We shall deal presently with the conjectured pedigree of the Horse, which naturally involves that family, and which presents an unbroken series from four-toed Perissodactyles to the present one-toed Horse, the various bones and teeth becoming modified in the course of the descent "with the regularity of clockwork." We are compelled to draw the line at functional second and third toes; directly these are no longer used the animal is a Horse in the strict sense! This is irrational and regrettable, but necessary for practical purposes, if

we are to continue the plan of defining the various families of Mammalia.

The genus *Equus*[1] contains not only the Horse, but the Asses and Zebras. The genus is to be distinguished as regards external characters by the following features:—The body is thickly clothed with hair, there is a more or less bushy tail and mane, the colours are apt to be disposed in stripes of black or blackish upon a yellowish brown ground; this is of course best seen in the Zebras, but the wild Asses also have some traces of it, if only in the single cross-bar of the African Wild Ass, and it is even "reversionary" in the domestic Horse at times. There are no horns upon the forehead or elsewhere; the fore-limbs or both pairs have a callous pad upon the inside, which is possibly to be looked upon as an aborted gland, possibly originally of use as secreting some odorous substance calculated to enable strayed members of the herd to regain their companions. The terminal phalanx of each of the (functionally) single digits is enclosed in a large horny hoof.

The main internal features of structure which divide this genus of Perissodactyles from the Rhinoceros or the Tapir, or from both, are: the existence of strong incisors, three on each side of each jaw; there are canines, but these are small and do not always persist in the full-grown mare. They are popularly known as "tusks" or "tushes." The first of the four premolars (the "wolf tooth") is small and quite rudimentary; it is often absent. As there are three molars, the present genus has the "typical" number of the Eutherian dentition, *i.e.* forty-four. In the skull the orbit is—as it is not in Tapirs and Rhinoceroses—completely encircled by bone. There is but one functional finger and toe on each hand (Fig. 121 C) and foot; the second and third digits are represented by mere splints, one of which may as an abnormality be enlarged, and reach nearly as far as the well-developed digit. There are even occasionally traces of digit number two.

The Horse, *E. caballus*, is to be distinguished from its congeners by the small callosities on the hind-limbs which it possesses in addition to the larger ones on the fore-limbs. The hairy covering of the tail is more abundant, as is also the mane. The head too is proportionately smaller, and the general contour

[1] Sir W. H. Flower, *The Horse*, London, 1890.

more graceful. Though Zebra markings are not usual upon *E. caballus*, there are plenty of examples of—what we may perhaps in this case term—a "reversion" to a striped state. The celebrated "Lord Morton's mare,"[1] whose portrait hangs in the Royal College of Surgeons, is an interesting case of this. It was as a matter of fact thought to be an example of that rather doubtfully-occurring phenomenon, "telegony." Its history is briefly this. The animal was the offspring of a mare that had previously produced to a male Quagga a hybrid foal. Afterwards a second foal was produced by the same mare to an Arab sire. This foal, the one in question, was striped, and hence was thought to be an example of male prepotency. But instances are known of unquestioned Horses which show the same stripes, such as a Norway pony which had not even *seen* a Zebra!

A last remnant of the naked palm of the hand and sole of the foot is left in the shape of a small bare area, smaller in the Horse than in the Asses, known technically as the "ergot," the term being that of the French veterinarians. As already mentioned, the Horse differs from the Asses and Zebras in the fact that the hind-limbs have callosities on the inner side. They are known as "chestnuts," and their nature has been much disputed. It has been suggested that they are the last rudiment of a vanished toe; but in all probability they are, as already suggested, traces of glandular structures, which are common upon the limbs in many animals (see above, p. 12).

It is a singular fact that there are apparently no wild Horses of this species. The case is curiously analogous to that of the Camel, which also is only known as feral or domesticated. Why the Horse should have become extinct as a wild animal, considering that when it does run wild it can thrive abundantly, is impossible to understand. Sir W. Flower thinks[2] that "the nearest approach to truly wild horses existing at present are the so-called Tarpans, which occur in the Steppe country north of the sea of Azov between the river Dnieper and the Caspian. They are described as being of small size, dun colour, with short mane and rounded obtuse nose." But he adds that there is no evidence to prove whether they are really wild. In favour, however, of their possibly being wild and indigenous European Horses, may be

[1] See Ewart, *The Penicuik Experiments*, Constable and Co., 1899.
[2] *The Horse*, London, 1890.

mentioned the fact that their general build and appearance is highly suggestive of the wild Horses sketched by primitive man upon ivory

A really wild Horse, and possibly the ancestor of the European domestic Horse, is *E. przewalskii* of the sandy deserts of Central Asia. This animal has been believed to be a mule between the Wild Ass and a feral Horse; but if a distinct form, and probability seems to urge that view, it is interesting as breaking down the distinctions between Horses and Asses. The species possesses the four callosities of the Horse, but has a poorer mane and an asinine tail.

There is no question that the Horse has been a domestic animal for very many centuries. Hieroglyphics appear to show that the Egyptians had not originally domesticated the Horse; it seems to have been first introduced among them by the Hyksos or Shepherd Kings[1] Whatever the date may be, it is certain that considerably anterior to the Egyptians the Assyrians and Phoenicians possessed Horses. In Western Europe the date of the introduction of the Horse seems to have been during the bronze epoch. Lord Avebury[2] has pointed out that out of eighteen cases of graves in which the remains of Horse were found, twelve contained metal implements, *i.e.* 66 per cent. This does not of course prove that the Horse was domesticated at that period, but it throws doubt upon the earlier occurrence of the Horse in abundance. The Horse, however, does occur on the Continent associated with the remains of man during the Quaternary period.[3]

Messrs. Cuyer and Alix enumerate between fifty and sixty domesticated races of Horse, not counting the supposed wild varieties which have been already referred to. These may be further subdivided; for instance, under the race "pony" we may distinguish the Irish, Scotch, and Shetland varieties, all of which, however, according to Sanson, have originated in Ireland. They are used, remark the authors above quoted, "par les jeunes filles des lords pour leurs promenades." The Arab, the Barb, the Suffolk Punch, etc., are among the numerous races of domestic Horses, into which to enter properly would require another volume, and that of large size.

[1] Cuyer and Alix, *Le Cheval*, Paris, 1886.
[2] Lubbock, *Prehistoric Times*, London, 1865.
[3] J. Geikie, *Prehistoric Europe*, London, 1881.

The Asses and Zebras differ from the Horse in the characters mentioned under the description of *Equus caballus*. In addition to these may be pointed out a feature to which attention has been directed by Mr. Tegetmeier.[1] According to him the period of gestation in the Horse is only eleven months; in the others more than twelve

Opinions as to the number of species of Asses differ. On the most liberal estimate there are three Asiatic and two African

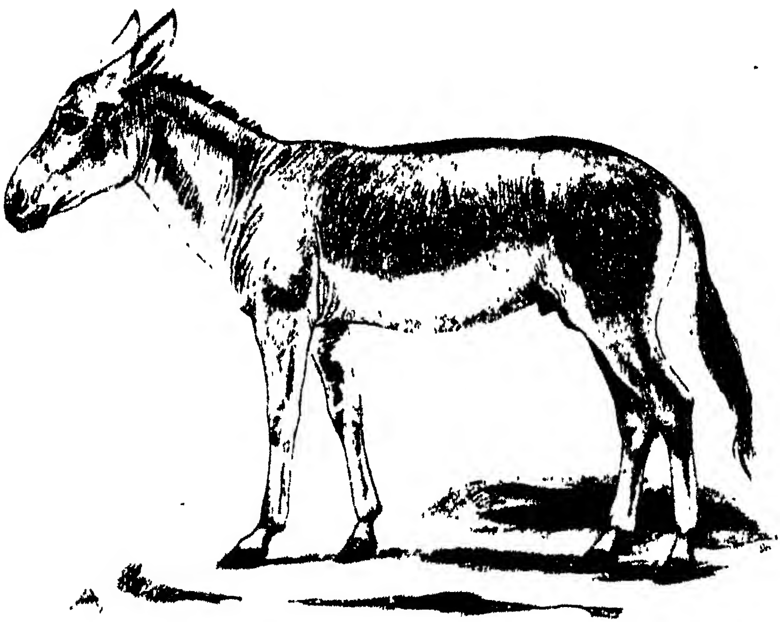

FIG. 125.—Asiatic Wild Ass. *Equus onager*. × $\frac{1}{20}$

species. The best known of the Asiatic Wild Asses is the Onager, *E. onager*. It is of a uniform yellowish, "desert" colour, with a dark stripe along the middle of the back, and is found in Persia, the Punjab, and the country of Cutch. The creature is of great swiftness; it has been stated to be untameable, but Mr. Tegetmeier makes the absolutely opposite statement that the Ass occasionally "becomes so tame as to be troublesome"! The Syrian Wild Ass, *E. hemippus*, hardly, if at all, differs from this.

The Kiang, *E. hemionus*, seems to have more claims to distinctness. In the first place it has a more limited and a

[1] *Horses, Asses, and Zebras*, London, 1895.

different distribution; it is confined to the high tablelands of Thibet at an elevation of 15,000 feet and upwards. In correlation with this habitat it has a thicker and more "furry" coat, which is, moreover, of a darker shade than that of the Onager. This coat is shed in the summer, and replaced by one which is not so dark in hue. It is an interesting fact that the African Wild Asses approach to the zebra type in having at least traces of stripings. There are apparently two species. The best known,

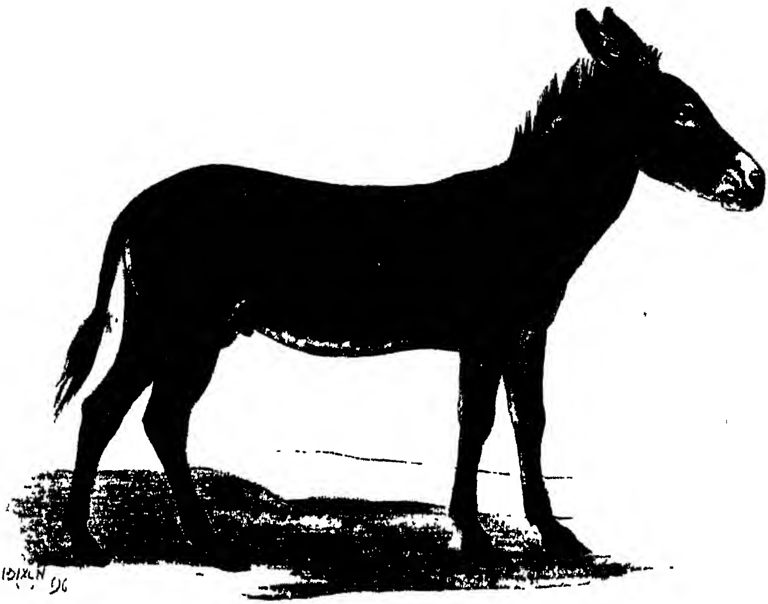

FIG. 126.—Nubian Wild Ass. *Equus africanus.* × $\frac{1}{20}$.

the Nubian Ass, *E. africanus,* is probably the parent of the domestic donkey. It has a dorsal longitudinal stripe, and another across the shoulder—in legend the marks of the Saviour. The matter of the name of this Ass seems difficult to decide. It has been called also *E. asinus* and *E. taeniopus.* It has been observed that this animal has a great aversion to water, and a delight in rolling in the dust—both of which characteristics argue a desert existence. But on the other hand the Kiang will plunge boldly into streams, yet it would seem to be the descendant of a purely desert form. The Ass is a longer-lived

animal than the Horse. Mr. Tegetmeier calls attention to a donkey living in 1893 which had been ridden fifty-five years previously. The Horse, on the other hand, lives not much more than twenty-five years.

A second species of African Wild Ass, *E. somalicus*,[1] is distinguished by its greyer colour, by the absence of the shoulder stripe, by the very faint development of the dorsal stripe, and by the presence of numerous cross stripes upon the legs. It has, too, smaller ears, and a longer and more flowing mane. Mr. Lort Phillips, an experienced naturalist and traveller, saw a herd of these Wild Asses in Somaliland, which he regarded as being of quite a new species. A living example in the Zoological Society's Gardens led Mr. Sclater to an identical conclusion, which was supported, as he pointed out, by the fact that this Ass has a different range to the African or Nubian Wild Ass.

Of the Zebras three species are usually allowed; these are *E. zebra*, the "Mountain" or "Common" Zebra, *E. burchelli*, *E. grevyi*, as well as *E. quagga*. Professor Ewart thinks that the Common Zebra, Burchell's, and the Quagga are not very distinctly marked off from each other. No one, however, has any doubt of the distinctness of *E. grevyi*. This latter differs from the rest in its larger size, in the large head and ears, and in the marked hairiness of the ears. It would seem to be a primitive type of Zebra, if the fact that the occasional reversion of hybrids to a parent form be allowed; for Professor Ewart found a cross-bred Zebra to present several characteristics in the face-marking of this, the finest of the Zebra tribe. Only four specimens of *E. grevyi* have been exhibited alive in Europe—two in Paris, and two in the Zoological Society's Gardens in London. The latter were presented to Queen Victoria by King Menelek of Abyssinia. The species was named by Professor A. Milne-Edwards in honour of a late President of the French Republic, from an example also sent by King Menelek.

The Common Zebra has closer and darker stripes than Burchell's, but not quite so close as in *E. grevyi*. It has also a very characteristic arrangement of stripes on the withers in the form of a gridiron. This latter is wanting in both the other species In *E. grevyi*, in fact, this part of the back is white. *E. zebra* has also a dewlap in front. *E. burchelli* has fewer and broader

[1] *Proc. Zool. Soc.* 1884, p. 540.

stripes, and between them lie in many cases shadow-stripes of a faint brown.

All these animals, and the Quagga too, are absolutely confined to Africa. Mr R. Crawshay,[1] in describing what he considered to be a new variety, remarked upon the curiosity of *E. burchelli*. "They remain out in the sun on the plains all day long, not retiring into covert at all. They are then an intolerable nuisance to any one in pursuit of other game; indeed this may be said of them at all times. If once they notice you, they

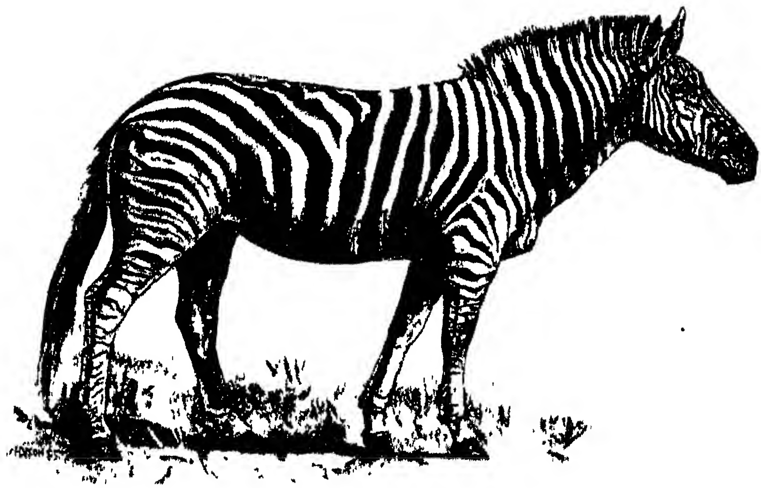

FIG. 127.—Burchell's Zebra. *Equus burchelli*. × 1/20.

draw in and mob you in their curiosity—only, however, when one takes no interest in them, for when they fancy they are the object of the intruder's attention, no animals are more watchful and cunning in safeguarding themselves. If only their curiosity were manifested in silence it would not so much matter, but it vents itself in snorts and thundering stampedes, which puts every beast within earshot on the *qui vive*."

Whether Burchell's Zebra[2] can be further subdivided into species or sub-species appears to be doubtful. Dr. Matschie considers that *Equus boehmi* may be regarded as a valid form, and in addition to this two sub-species, *E. burchelli granti* and

[1] *Proc Zool. Soc.* 1895, p. 688.

[2] See Pocock, *Ann. Nat. Hist.* (6) xx. 1897, p. 83.

E burchelli selousi, have been proposed for what are at most local races. But it is at present far from certain whether their distribution favours this subdivision.

The Quagga was more striped than is sometimes represented in illustrations. According to Dr Noack, from whose paper [1] upon the animal I quote here, the transverse stripes reached back as far as the buttocks; they were, however, completely absent from the legs. The animal is, as every one knows, probably completely extinct. In the year 1836 it was still abundant; in 1864 the last specimen ever exhibited was received by the Zoological Society. Mr. W. L. Sclater thinks that it may have survived in the Orange River Colony as late as 1878, but admits that any certainty is difficult, as it was frequently confounded by the Boers with Burchell's Zebra. Its rarity is emphasised by the fact that it is not mentioned in the recent work of that most skilful of hunters, Mr. F. Selous. Gaudry places the Quagga nearest of all living Equidae to the *Hipparion gracile* of Pikermi.

Fossil Equidae.—The existing Equidae all belong to the genus *Equus*, though there are some who would (quite unnecessarily) divide off the Zebras as a genus *Hippotigris*. The genus *Equus* itself goes back in time to the Pliocene, during which epoch there lived in India *E. sivalensis*, the same species according to some with the *E. stenonis* of Europe. None of these species, Old World or New, are easily to be separated from *E. caballus*. But many names have been given to them. It is of course perfectly conceivable that they may have differed among themselves as much as do the existing Zebras and Asses, the separation of which would be hardly possible did we know their bones only. There are, however, extinct genera, undoubtedly related so closely to *Equus* as to be placed in the same family, though clearly separable as genera. *Hipparion* is one of these genera; its remains are known from Europe, Asia, and North Africa, from beds of Miocene and Pliocene times. A large number of different species have been described. It was a beast of about the size of a Zebra. The principal characters are that each foot has three toes, of which, however, the two side ones are smaller than the central toe. There is a marked round fossa on the maxillary bone, a feature shared by the South American *Onohippidium*.[2] The pattern of

[1] "Das Quagga," *Zool. Garten*, 1893, p. 289

[2] Of this Horse, remains have been lately discovered (see Lönnberg, *Proc. Zool.*

the molar teeth is, too, a little different from that of *Equus*. *Protohippus* of the North American Pliocene is also three-toed, but the two additionally-developed toes are smaller than in *Hipparion*. Other forms are dealt with below in connexion with the ancestry of Perissodactyles. It is a curious fact about *Hipparion*, which is not now regarded as on the direct line of equine descent, that the edges of the enamel plates of the molars may show a complicated folding very like that presented by that clearly terminal form of Perissodactyle life, the gigantic *Elasmotherium*. This is indicative of high specialisation, which ended in extinction.

Ancestry of the Horses.—The **Lophiodontidae** and the **Palaeotheriidae** are two of the most interesting extinct families of Perissodactyles; for among them we find what would appear to be the ancestral forms of both the existing Tapirs and Horses. The Rhinoceroses also would seem to be derivable from the Palaeotheriidae. The very vagueness of the characters of these creatures, considered from a classificatory point of view, has led to much diversity in their placing. This though gratifying to the evolutionist is tiresome to the writer who wishes to give a methodical account of their various characters. It will be best perhaps not to attempt an accurate placing or to reconcile conflicting opinion, but to give some salient features of osteology which lead to the belief in their relationship to existing groups of Perissodactyles. A book upon the history of mammals would be incomplete without some account of that well-ascertained series of forms which seem to connect these primitive Perissodactyles with the modern Horse. *Equus*, in fact, is not only the "show horse" of the doctrine of evolution, but also the "stalking horse."

In the Eocene of both Europe and America are met with a number of forms from which we may start. *Hyracotherium*, regarded on the one hand as the type of a sub-family of the Equidae themselves, and on the other as a member of the family Lophiodontidae, was a small-sized animal, three feet or so in length; it possesses the complete Eutherian dentition with a slight diastema. The orbits are not separated from the temporal fossa; the fore-limbs were four-toed, the hind three-toed, with moderately long metapodia, especially on the hind-feet. The shoulder blade

Soc. 1900, p. 379) in the cave which produced the remains of *Glossotherium*. A piece of skin covered with Fox-red hair, possibly spotted with paler areas, is believed to be a relic of *Onohippidium*.

has a well-marked coracoid process. The radius and ulna are separate, so too are the tibia and fibula. *Eohippus*, belonging to the same sub-family, is slightly more primitive; for the hind-feet have a rudiment of digit I. *Orohippus* is a little nearer to the Horses in that the molar teeth have acquired a little further advance towards the equine type. Instead of the tubercles of the teeth remaining for the most part separate, they have fused into a set of ridges, of which, however, the pattern is less complex than in the modern Horses. In other respects *Orohippus* is much like *Hyracotherium*. *Pachynolophus* seems to be but a synonym.

The next stage is shown by *Mesohippus*, a Lower Miocene form, usually referred to the neighbourhood of *Palaeotherium*. It has nearly lost one of the toes of the fore-foot, a rudiment only remaining; the metapodials, at any rate of the fore-feet, seem to be slightly increased in length. The orbit is not encircled by bone, but there is a strong process from the frontal, which nearly meets the zygomatic arch.

Anchitherium, from the Upper Miocene, is not far removed in structure from the last-mentioned form; it is a trifle nearer the existing Horse in several points. The ulna is further reduced and fused with the radius below; the rudiment of digit V is still more rudimentary; the two lateral digits are smaller in proportion to the central one than they are in *Mesohippus*; the fibula is fused below with the tibia. From this form to *Equus* is a small series of steps, characterised by the still further reduction of all the digits except III, by the still further reduction of the already rudimentary ulna and fibula, and by the increasing depth of the molar teeth, which are of course, in *Equus*, hypselodont.

Another interesting conclusion may seem to follow when we consider the geographical range of the ancestral Horses. *Hyracotherium* and *Pachynolophus* occurred both in the Old and New World. From them may have arisen the Horses of both hemispheres. After that point there is a division. *Mesohippus* is American, and we get at *Equus* in that continent through *Desmatippus* and *Protohippus*. On the other hand there are no remains known of *Mesohippus* in Europe; and unless subsequent researches prove the existence of *Mesohippus*, we have to rely upon forms which are placed with *Anchitherium* and *Hipparion*.

It seems that in America the next genus in the direct line of equine descent to *Mesohippus* is *Miohippus*. It is smaller in

size than *Anchitherium*, to be considered immediately. The odontoid process of the axis is just beginning to assume the characteristic spout-like shape of that of the existing Horse and many modern Ungulates. The median digit of both fore- and hind-limbs has become greatly enlarged as compared with the corresponding digit of earlier forms

It is held, however, that *Anchitherium* is not on the direct line of descent either in America or in Europe, in both of which it occurs. Its teeth are in some respects less Horse-like than in some of the more ancient genera, to which the converse would be expected on the descent theory. Its hoofs are much elongated and flattened, a mark of specialisation and not appropriate to a creature holding an intermediate position in the equine series. Both the American (*A. equinum*) and the European species (*A. aurelianse*) are of very large size, larger than its successors, and such "alternations in bulk are unlikely."

The genus *Desmatippus* of Professor Scott[1] fills in the gap between *Miohippus* and *Protohippus*. The molars and premolars are brachyodont, but there is a thin deposit of cement in the tooth valleys, leading towards the more complete filling of these valleys with cement, which is found in *Protohippus*. This genus of Horses, of which there is at present but one species, *D. crenidens*, was three-toed, and "the lateral digits, so far as can be judged by fragmentary remains, were still fairly developed, and though much more reduced than in *Miohippus*, appear to be somewhat less so than in *Protohippus*."

To recapitulate, the following is the probable series of equines in America—*Mesohippus*, *Miohippus*, *Desmatippus*, *Protohippus*.

The development of the limbs of the Horse shows a most interesting series of stages, which correspond in part to the ancestral forms which palaeontology seems to prove to be the line of the descent of our existing Equidae. This matter has recently been elucidated by Professor Ewart, who details the following facts and comparisons:—

In the youngest embryo (about 20 mm. in length) the humerus is somewhat curved, and considerably longer than the radius and carpus taken together. The first-named bone is shorter in the adult, and the proportions of that bone in the young as well as its curvature are suggestive of that ancient

[1] *Trans. American Phil. Soc.* xviii. 1896, p. 55.

Ungulate *Phenacodus* (see p 202). In the next stage (an embryo of 25 mm.) the humerus has slightly decreased in proportionate length, and has come to be more like that of *Hipparion*. In both of these embryos it should be noted that the ulna is complete and separate from the radius. In the second of the two it has more distinctly acquired the form which it will possess in the adult. The second metacarpal—one of the splint bones of the adult—is tipped with a small nodule of cartilage, which is clearly the representative of one or more of the phalanges belonging to that digit.

Fam. 2. Tapiridae.—The Tapirs may be distinguished from the Horse and from the Rhinoceros tribe by a few characters, which are as follows:—

The dentition is generally the full one of forty-four teeth. The premolars in the more ancient forms are unlike the molars, but like them in more recent forms. The molars of the upper jaw have two crests parallel and united by an outer crest. The fore-feet have four, the hind-feet three toes.

The family is fully as ancient as that of the Equidae, but the specialisation of the toes never advances so far. The modern representatives of the order are, so far as the feet are concerned, in the condition of very early representatives of the equine stock. Nor do the teeth of the Tapirs ever reach the complicated pattern of that presented by at least the modern Horses, or indeed of the Palaeotheres. Apart from this it is not an easy matter to distinguish accurately between these several families, including the Lophiodontidae, which, as already mentioned, is placed nearer to the Tapiridae than to the Palaeotheriidae. Indeed the differentiation of these two families, the Tapiridae and the Lophiodontidae, seems to be a matter of the greatest difficulty. The difficulty is well emphasised by the fact that naturalists disagree most profoundly as to the relations of various genera of extinct Tapir-like animals. For Mr. Lydekker the genus *Lophiodon* includes also the American genera *Isectolophus* and *Systemodon*, which are placed by Zittel in the sub-family Tapirinae as opposed to Lophiodontinae, which contains *Lophiodon* and *Helaletes*. The existing Tapirs can be differentiated from the existing Horses with great ease, as the following account of the existing genera will show.

The genus *Tapirus* is now met with only in South and

Central America, and in the Malay Peninsula and the islands of Java and Sumatra. This animal is in many respects the most ancient of existing forms referable to the Perissodactyle order It has four toes on the front-feet, though only three on the hind-feet. The number of teeth is 42—nearly the typical Eutherian number. The Tapirs are always moderately-sized animals, entirely covered with hair, and usually of a brownish-black colour. The Malayan Tapir is, however, banded broadly with white—a single band; the young of the Tapir is spotted, and striped with white. The nose and upper lip conjoined are pro-

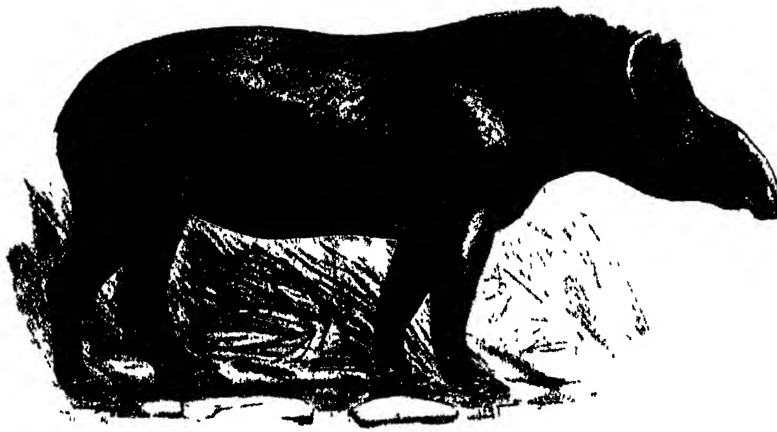

Fig. 128.—American Tapir. *Tapirus terrestris.* $\times \frac{1}{15}$.

duced into a short trunk, precisely comparable with that of the Elephant. As in the Rhinoceros—and in this both contrast with the other existing Perissodactyle genus *Equus*—the temporal fossa is not separated from the orbit by bone. Of existing Tapirs there are at any rate *T. terrestris*,[1] *T. roulini* (the "Tapir Pinchaque" of Cuvier), *T. dowi* and *T. bairdi* in America (the last two being sometimes separated into a distinct genus, *Elasmognathus*, on account of the prolongation of the ossified mesethmoid), and *T. indicus* in the East. The tapir, probably *T. terrestris*, is described by Buffon as "a dull and gloomy animal." It is certainly mainly nocturnal in habit. The name *terrestris* was given by Linnaeus, who placed it in the same genus as *Hippo-*

[1] *T. leucogenys* and *T. ecuadorensis* are probably not distinct, the latter being in reality *T. terrestris*, the former *T. roulini*.

potamus amphibius; hence the epithet applied to the Tapir. But as a matter of fact it loves marshy neighbourhoods, and is in a way amphibious. This does not of course apply to the Andesian *T. roulini*, which inhabits the cordillera of Ecuador and Colombia. The distribution of existing Tapirs is, as is so often the case, restricted when compared with that of their extinct congeners and allies. In Europe the remains of the genus *Tapirus* are abundant from Pliocene strata, and its remains are there known from as far back as the Miocene. The genus is thus one of the very oldest forms of Mammalia at present inhabiting the earth.

FIG. 129.—Malayan Tapir. *Tapirus indicus*, young. × $\frac{1}{10}$. (From *Nature*.)

The Malayan Tapir is to be distinguished from the American (*T. terrestris* —the other species have not been dissected) by the greater development of the valvulae conniventes in the intestine, the absence of a moderator band in the heart, and the less elongated caecum, which is sacculated by only three bands, there being four in *T. terrestris*.[1] The animal frequents the most retired spots among the hill woods, by which habit it seems

[1] See Beddard, *Proc. Zool. Soc.* 1889, p. 252, and other papers there cited, for the anatomy of the Tapir.

largely to escape the Tiger, its most formidable foe in those regions of the world. Its quickness of senses enables it also to slip away with rapidity. It can proceed at a great pace when disturbed, and can readily push its way through obstacles. The young animal, like that of the American species, is dark brown with yellowish spots. It is stated by Mr. H. N. Ridley that the young animal lies during the hot part of the day under bushes, in which situation "its coat is so exactly like a patch of ground flecked with sunlight that it is quite invisible." It is interesting to note that here, as with some other animals, it is the young that are especially protected by such mechanisms. Moreover, some of the spots are round and some are more elongated, so that the resemblance to spots of sunlight which come in a direct and in a slanting direction is greatly increased. Even the colours of the adult are not so conspicuous when it is in its native haunts as might be supposed. The breaking up of the ground colour into tracts of two different colours prevent it from striking the eye so plainly as if it were of one colour throughout. "When lying down during the day it exactly resembles a grey boulder, and as it often lives near the rocky streams of the hill jungles, it is really nearly as invisible then as it was when it was speckled."[1]

Fam. 3. Rhinocerotidae.—This family is to be distinguished from the preceding by a number of characters, which though not universal are general. In the first place, there are commonly horns, or a horn, consisting of what appears to be an agglomeration of hair-like structures fixed upon a roughened patch of bone on the surface of the nasals. The incisors are diminished or defective, and the upper canines are often wanting. The molars and premolars are alike. The fore-feet are four- or three-toed, but are functionally tridactyle; the hind-feet are three-toed. The skeleton in this family is massive, and the limbs relatively short. The skull, as in the Tapirs, has a confluent orbit and temporal fossa. The upper lip is generally more or less prehensile; the body is as a rule—to which the Pleistocene Hairy Rhinoceros is of course an exception—rather sparsely covered with hair. In this feature the Rhinocerotidae contrast both with the Tapiridae and the Equidae. The family in reality contains but one existing genus, though three have been instituted, viz.

[1] *Natural Science*, vi. 1895, p. 161.

Rhinoceros, Ceratorhinus, and *Atelodus.* As there are so few existing species the subdivision of animals which agree in so many and such highly-characteristic features seems to be an unnecessary procedure. The existing Rhinoceroses are but a fragment of the total number of known forms from past epochs. The family is very markedly on the wane.

The genus *Rhinoceros* is characterised by its heavy build and thick, almost smooth, skin—smooth, that is to say, so far as concerns the slight development of hair—which is often thrown into folds. There is one or there are two horns on the fore-part of the head, which are, as has already been pointed out, structures *sui generis*, and not exactly comparable with the horns of other living Ungulates. There are three nearly equal toes on both fore- and hind-limbs. The canine teeth of existing species have disappeared; the incisors are, or are not, present; the molars and premolars are three and four in each half of each jaw.

The visceral anatomy of the Rhinoceros has been much investigated so far as concerns the Asiatic forms. A curious feature, which serves to discriminate some of the Asiatic species from others, is to be seen in the small intestine. In *Rh. indicus*[1] this gut is furnished with numerous long cylindrical narrow outgrowths "like tags of worsted"; in the allied *Rh. sondaicus* these tags are present, but are flatter and broader; while in the two-horned *Rh. sumatrensis* there are no tags at all, but only smooth valve-like folds Another mark by which these species can be distinguished depends upon the variation in the presence or absence of certain glands imbedded in the integument of the foot —the so-called "hoof glands." These occur in *Rh. indicus* and *Rh. sondaicus*, but are absent in *Rh. sumatrensis.*

Sir W. Flower[2] studied some years since the skull features which serve to differentiate the existing forms.

In *Rh. sumatrensis* the two long downward processes of the squamosal bone, termed respectively post-glenoid and post-tympanic, do not unite below the auditory meatus. In this the species in question agrees with the African forms but not with the one-horned Asiatic species, where the two processes completely fuse. Again, another character, though perhaps less important,

[1] Garrod, *Proc. Zool. Soc.* 1873, p. 92; *ibid.* 1877, p. 707. Beddard and Treves, *Trans. Zool. Soc.* xii. 1887, p. 183.

[2] *Proc. Zool. Soc.* 1876, p. 443.

is the sloping backwards instead of forward of the occipital crest in all two-horned species, whether African or Asiatic.

The Asiatic Rhinoceroses have, what the African animals have not, functional incisor teeth throughout life. It has been proposed on these and other grounds to separate generically the African and Asiatic forms.

The Asiatic Rhinoceroses include three well-differentiated species, in all of which the skin is much thrown into folds. *Rh. indicus* is the largest form. It is one horned, and has enormous folds of skin at the neck and hanging over the limbs.

FIG. 130.—Indian Rhinoceros. *Rhinoceros indicus.* × $\frac{1}{40}$.

So like artificial armour is this thick plating, that Albrecht Dürer may be excused for having given the beast the appearance of being actually mail-plated in a sketch which he made of a specimen sent over to the King of Portugal in 1513. This particular beast, one of if not the first sent over to Europe, proved so intractable in disposition that the king sent it as a present to the Pope. But "in an access of fury it sunk the vessel on its passage"! The horn of this and of other species was held until almost our times to have medicinal and other more curious values. So recently as 1763 it was gravely asserted that a cup made of its horn would fall to pieces if poison were poured into it. "When wine is poured therein," wrote Dr. Brookes in the year referred to, "it will rise, ferment, and seem to boil; but when

mixed with poison it cleaves in two, which experiment has been seen by thousands of people." John Evelyn also wrote of a well in Italy which was kept sweet by a Rhinoceros' horn. This species seems to be long-lived, even in captivity; a specimen now to be seen in the Zoological Society's Gardens has been there since the year 1864.

Rhinoceros sondaicus, the Rhinoceros of the Sunderbunds, has a much wider range than the last species or Indian Rhinoceros

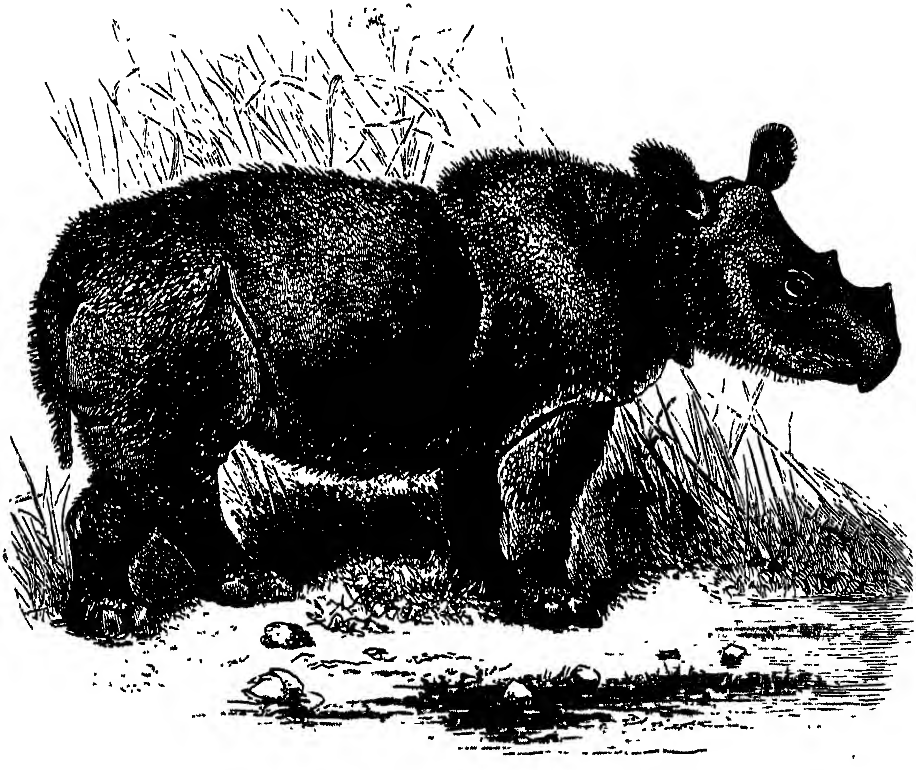

FIG. 131.—Sumatran Rhinoceros. *Rhinoceros sumatrensis*. × $\frac{1}{15}$. (From *Nature*.)

This is unknown out of India itself, and is there limited to a small region; the Sondaic form is found in Bengal and in the Malayan Islands. It is a smaller species, and the armour has a tesselated appearance. The female generally, if not always, is hornless.

The Sumatran species, *Rhinoceros sumatrensis*, is to be distinguished from the last two by its two horns. It is also covered

by a much thicker coat of hairs, which are sometimes blacker and sometimes redder. On account of its two horns it has been proposed to separate it from the other Oriental species into a distinct genus, *Ceratorhinus.* The animal has much the same range as the last species, but extends to Borneo. A variety of this species with hairy ears, from Assam, has been separated as a distinct form, under the name of *Rh. lasiotis,* by Mr. Sclater. The animal upon which that species was founded was until quite recently living in the Zoological Society's Gardens.

There are only two certainly-known species of Rhinoceros in Africa. These are the White Rhinoceros (*Rh. simus*) and the

FIG. 132.—Hairy-eared Rhinoceros. *Rhinoceros lasiotis.* × $\frac{1}{30}$.

Black Rhinoceros (*Rh. bicornis*). The origin of the names is not easy to understand, since the "white" animal is, if anything, darker in colour than the Black Rhinoceros. It is stated, however, that in past years the specimens of *Rh. simus* found in the south-west of Cape Colony were "paler and whiter in colour than those in the north-east." At present there are no grounds for distinguishing the species by their colour characters. But they are plainly distinguishable on other grounds. *Rhinoceros simus* has a square upper lip, and in relation to this crops the herbage upon the ground. *Rh. bicornis* has a prehensile upper lip projecting beyond the lower, and in a corresponding fashion feeds principally upon the branches of shrubs. It has been pointed out by Mr.

Coryndon[1] that the calf of *Rh. simus* "always runs in front of the cow, while the calf of *Rh. bicornis* invariably follows its mother." Both animals of course have two horns, and upon the varying proportions of the horns a large number of "species" have been made in the past. It is stated that the longest horn of the "White Rhinoceros" known measures 56½ inches; while that of

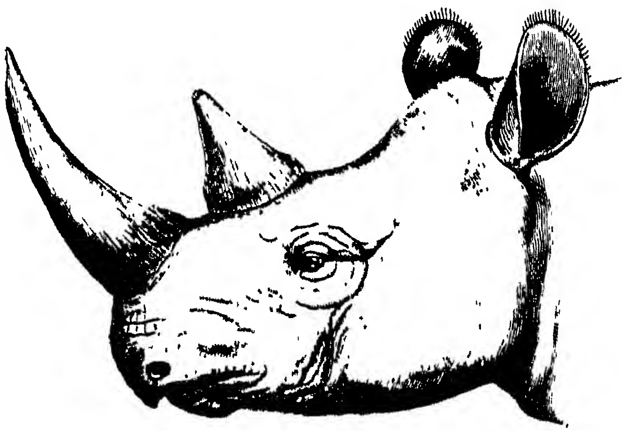

FIG. 133.—Head of *Rhinoceros bicornis*.

R. bicornis is shorter, 40 inches being apparently the maximum. But the animal is smaller.

The possible third African species of *Rhinoceros*[2] has been provisionally named after Mr. Holmwood, and is based upon two horns 41 and 42 inches long, which may be abnormal horns of *Rh. bicornis;* but they are thinner and have a smaller pedicel.

Extinct Rhinocerotidae.—The existing Rhinoceroses are thus confined to Africa, to certain parts of the continent of Asia, and to some of the large islands lying to the south of that continent But formerly the genus, and allied genera, had a wider range. As far back as the Miocene we meet with remains of Rhinoceroses closely allied to existing forms. The more ancient forms have, as is natural, more ancient characters. Thus in *Rh. schleiermacheri* of the Miocene, canines appear to have been present. The Miocene *Aceratherium*, primitive in the absence of horns as its

[1] *Proc. Zool. Soc.* 1894, p. 329. See also Mr. Selous' paper in *Proc Zool. Soc.* 1881, p. 275.

[2] P. L. Sclater, *Proc. Zool. Soc.* 1893, p. 514.

name denotes,[1] had also canines and, in one species, six incisors in the lower jaw. This *Aceratherium* had, moreover, four toes in the fore-feet. In the Miocene and later the Rhinoceros existed in Europe and America. There was even a purely northern form, the *Rh. tichorhinus*, which possessed a woolly covering and had the same range as the Mammoth. This Rhinoceros was two-horned.

The post-Pliocene and European *Elasmotherium* was a colossal rhinocerotine creature. This great beast had two horns and a body 15 feet long. Its limbs are not known, and as the teeth are different from those of Rhinoceroses in general, it may not have belonged to this group at all, though Osborn is inclined to derive it from *Aceratherium*, admitting at the same time that the evidence is "decidedly slender." The teeth in fact are like those of a Horse in being hypselodont and prismatic in form. As to the two horns, they were apparently not exactly like those of typical Rhinoceroses; there was an enormous horn posteriorly, supported on a huge boss of bone, and in front of this a roughened spot suggests a smaller or at least a much more slender horn.

It is important to notice that fossil Rhinoceroses belonging to the restricted genus *Rhinoceros* were in Europe invariably two-horned; it is only in India, where they still exist, that one-horned forms are met with in a fossil state.

The Rhinoceroses of America were mostly hornless. *Diceratherium* is an exception; but in many cases it had two parallel not successive horns, and these were, to judge from the slight prominences, but feeble in development, and perhaps hardly exactly comparable with the formidable weapons of the Old-World forms. *Aceratherium tridactylum*, with indications of paired horns, may be ancestral to *Diceratherium*. The American forms have weak and slender nasals in correspondence with the absence of horns; the sagittal crest is retained in contradistinction to the great flattened surface of the skull in the horned Rhinoceroses. *Aceratherium* of both divisions of the globe probably represents the ancestral group of the horned and the hornless forms. This being the case it is highly interesting to note a distinct convergence in the quite

[1] Quite recently, however, a species, *A. incisivum*, preserved at Darmstadt, has been found by Professor Osborn to possess a slight rugosity upon the frontal bones, which probably indicates the presence of a rudimentary horn, and the same author is apparently inclined to place in *Aceratherium* the horned *Teleoceras* (see p 261).

separate American genera towards the European horned genera. A genus sometimes united with *Aceratherium*, but still differing from it in some points, is *Aphelops* (*Teleoceras*).[1] This animal is more nearly approximated to "the modern standard" of Rhino-

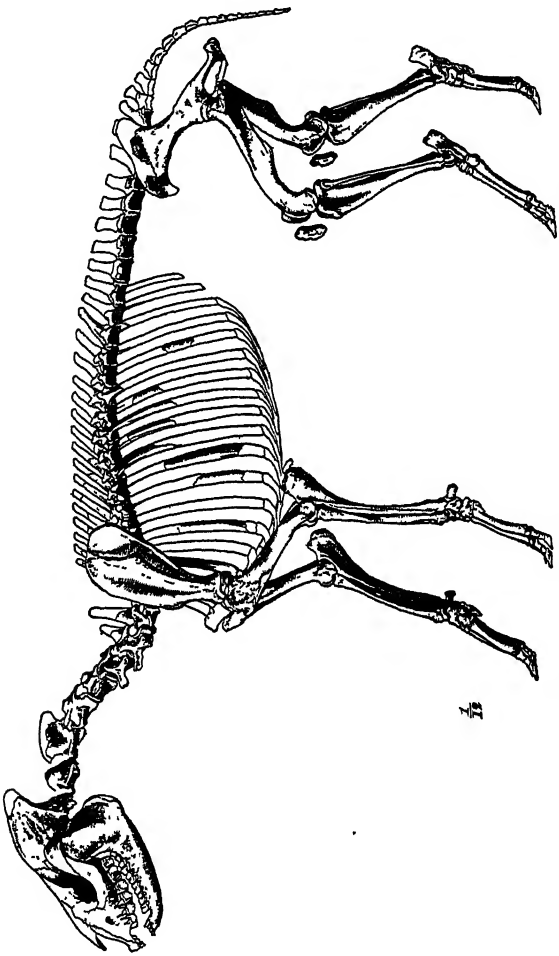

Fig 134.—Skeleton of *Hyracodon nebrascensis*. $\times \frac{1}{12}$. (After Scott.)

ceroses than is its possible ancestor *Aceratherium*. The skeleton in general is more robust, even surpassing that of modern forms, and approaching the *Hippopotamus*. There is a reduction in the upper incisors, which are limited to two pairs, and the lower molars

[1] Osborn, *Bull. Amer. Mus Nat. Hist.* x. 1898, p. 51.

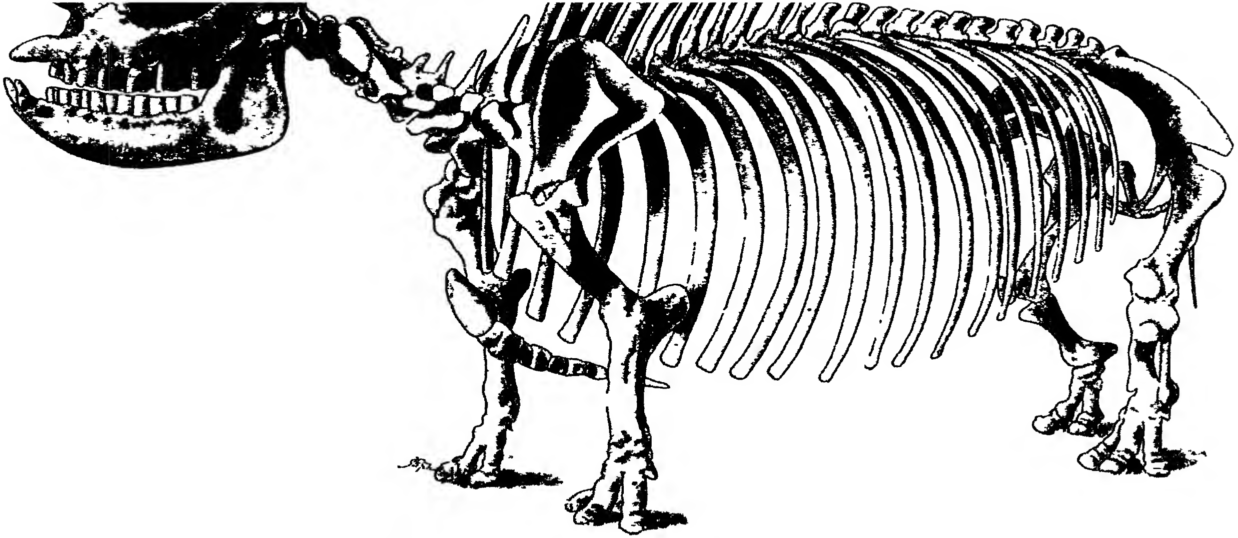

FIG. 135.—Skeleton of *Aphelops* (*Teleoceras*) *fossiger*. $\times \frac{1}{15}$. (After Osborn.)

are reduced to five. The lower incisors are only two. The sagittal crest is less marked; the fifth digit is reduced to a tiny nodule representing the metacarpus. It had a small nasal horn. There are numerous other details of likeness to modern Rhinoceroses in this creature, which has only community of descent with them from the older hornless forms, such as *Aceratherium* and *Caenopus*. In the genus *Peraceras* the upper incisors are as completely gone as in the living African Rhinoceroses.

The most ancient rhinocerotine types[1] are the Hyracodonts and the Amynodonts. They both date from the Eocene, and became extinct in the succeeding Oligocene. *Hyracodon*[2] (Fig. 134) was "an agile, light-chested, and rather long-necked" type, resembling a Horse in build. There were no horns present, but the hoofs were more like those of the Horses than of the existing Rhinoceroses. These animals were apparently plain dwellers and defenceless, which is held to account for their compact hoofs and outward similarity to a Horse. The genus is Oligocene. The dental formula is I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{3}$ M $\frac{3}{3}$.

It is surmised by Professor Scott that the number of dorso-lumbar vertebrae was twenty-three or twenty-four. The radius and ulna are complete and separate bones, but the latter is somewhat reduced There are four metacarpal bones, of which, however, the fifth is much reduced. The animal is only three-fingered. The tibia and the fibula are distinct, and show no tendencies towards fusion; but the fibula is much reduced. There are only three metatarsals and three toes. Had this line, which is to be regarded as a side branch of the Rhinoceros stem, not died out, it would probably have resulted, thinks Professor Scott, in monodactyle—very Horse-like types. It is later than the next genus to be described, *Hyrachyus*, of which it is possibly a descendant. An intermediate type, *Triplopus*, appears to bind together *Hyracodon* and *Hyrachyus*.

In *Hyrachyus agrarius* the skull is long and narrow, the facial region being markedly longer than in existing Rhinoceroses. The mastoid portion of the periotic bone is widely exposed upon the outer face of the skull, which is, as has been said, not the case with the existing genus *Rhinoceros*. The dentition is the complete Eutherian dentition of forty-four teeth. The upper

[1] See Osborn, *Mem. American Mus. Nat. Hist.* vol. i. pt. iii. 1898.

[2] Scott, in Gegenbaur's *Festschrift*, ii. 1896, p. 351.

molar teeth are strikingly like those of the genus *Rhinoceros*. The fore-feet are pentadactyle, but functionally tetradactyle;

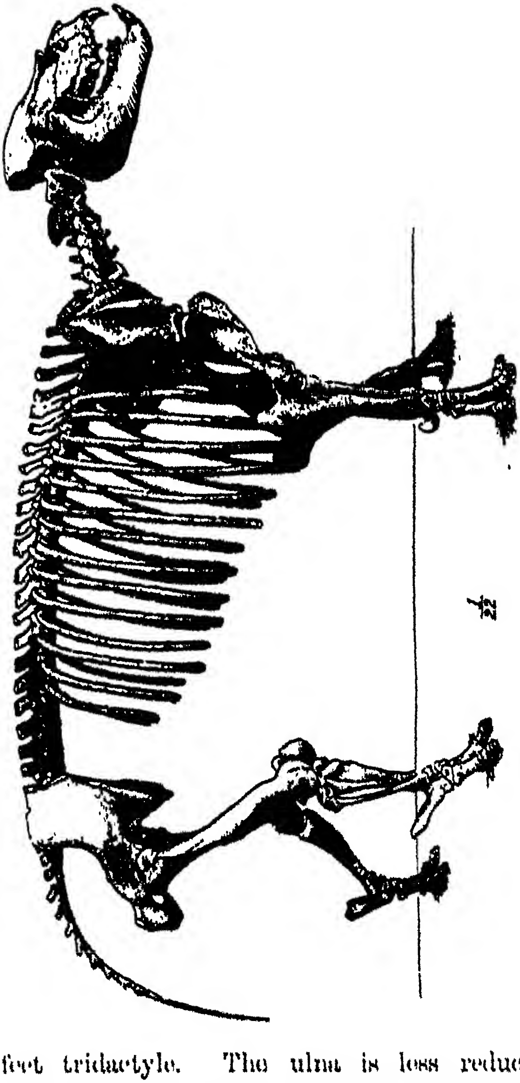

FIG. 136.—Skeleton of *Metamynodon planifrons*. $\times \frac{1}{22}$ (After Osborn and Wortman.)

the hind-feet tridactyle. The ulna is less reduced than in *Hyracodon*, and the dorso-lumbar vertebrae are twenty-five.

The Amynodonts were short, heavy types, probably marsh-haunting in habit, and possibly with a proboscis like that of the Tapir. The orbit is higher than it is in the purely terrestrial

Hyracodonts, and it is suggested that when swimming it was raised above the surface as with the Hippopotamus. "This feature," observes Professor Osborn, "with the long curved tusks, undoubtedly used in uprooting, suggests the resemblance between the habits of these animals and those of the hippopotami." There were no horns in the Amynodonts. The face is shorter than in the Hyracodonts, and the mastoid is covered as in recent Rhinoceroses. The canines are very strongly developed into tusks, but the incisors show signs of disappearance. We know of the genera *Amynodon*, *Metamynodon*, and *Cadurcotherium*. All except the last, which is European, are American in range.

Fam. 4. Titanotheriidae.—These Oligocene Ungulates, often attaining to large dimensions, are nearly peculiar, so far as is at present known, to the North American Continent, and are at least most abundant in it.[1] Many generic names, such as *Titanotherium*, *Brontotherium*, *Brontops*, *Titanops*, and *Menodus*, have been given to them; but a recent study of the entire material accessible for description or already described has led Professor Osborn to the opinion that there was but a single genus, to which the name *Titanotherium* must be applied. Of this genus there are some thirty well-characterised species, of which the gradual evolution can be traced from the lowest strata of the White River beds where their remains occur. An entire skeleton of *T. robustum* enables us to understand the osteology of these forms and to compare them with other Perissodactyles. This animal was more than 13 feet long, standing some 7 feet 7 inches in height. It seems to have presented during life the aspect of a Rhinoceros with perhaps a touch of Elephant. The skull is not unlike that of a Rhinoceros in general dimensions and shape; but there are a pair of apparent horn cores anteriorly, which are smaller in the more ancient forms and acquire a large size, a forward direction with a divergence of the two in the later forms. A glance at the accompanying figures of skulls (Fig. 137) of early and later Titanotheres will exhibit the changes in this particular which the skulls underwent in the lapse of time occupied by the deposition of these Oligocene beds. The nasals are short in the later, longer in the more early species, such as *T. heloceras* and *T. coloradense*. The zygomatic arch projects much, and is "shelf-like" in the later forms, the skull thus getting an immense breadth, which,

[1] Remains of the genus have been met with in the Balkans.

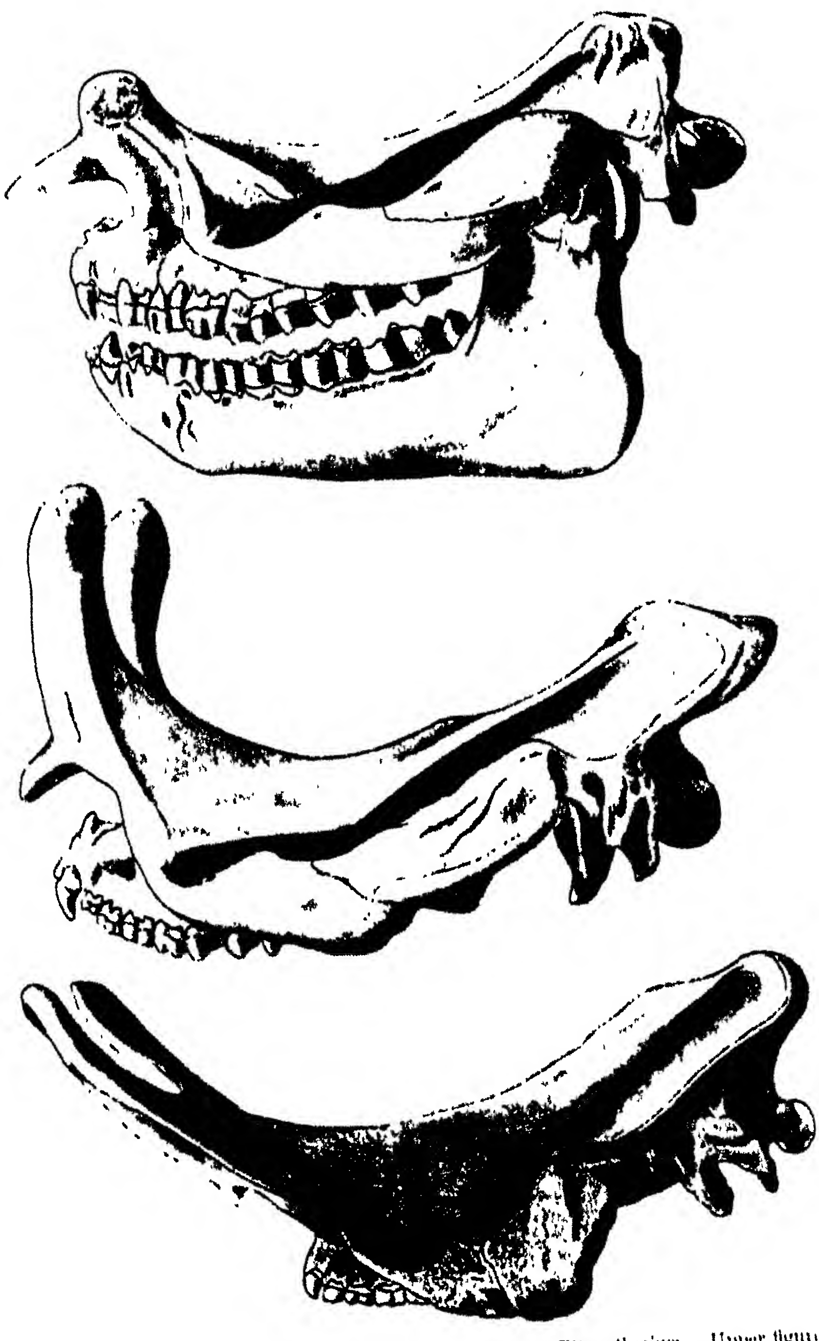

FIG. 137. Three figures showing the cranial evolution of *Titanotherium*. Upper figure, *T. trigonoceras*; middle figure, *T. elatum*; lower figure, *T. platyceras*. (After Osborn.)

together with the long and divergent horn cores, must have given to the living animal a most bizarre appearance. It is an interesting fact that this animal, though a Perissodactyle, agrees with the Artiodactyla in the nineteen dorso-lumbar vertebrae, of which seventeen bear ribs

The genus further agrees with the Artiodactyles in the structure of the carpus. The toes of the fore-limb are four, those of the hind-limb three; but while the hind-limb is undoubtedly Perissodactyle in the arrangement of its component parts, the fore-limb shows a hint of an Artiodactyle mode of structure. This limb is paraxonic, the axis of the limb passing between the two middle digits. It may be that this genus represents more nearly than any other Perissodactyle or Artiodactyle the primitive stem from which both have diverged, though, of course, it is not old enough to be very near to the actual ancestor. The molar dentition is the typical one; the incisors seem to vary as to their presence or absence, and, if present, in their numbers. In comparing the older with the more recent forms it is noteworthy that there has been an increase of size exactly as there has been during the evolution of the Camels and some other groups of Ungulates. As already mentioned, the size of the horn cores also increases until it culminates in the extraordinary species, *T. platyceras* and *T. ramosum*, in which these are half as long as the skull, flattened in form, and connected at their bases by a "web" of bone. Arrived at this amount of specialisation the genus *Titanotherium* apparently exhausted its capacities for modification and ceased to be. The many generic names may be explained by sexual differences on the one hand and an incomplete knowledge of connecting links on the other.[1]

Palaeosyops is somewhat like a Tapir in build, the skull especially resembling that of the Tapir. As in *Titanotherium* the molar teeth, instead of having an outer wall formed by fused cusps, have a W-shaped outer wall on one side and two or one cusps on the opposite side. It is, moreover, an Eocene form, and in correspondence with its greater age is more primitive in some points of structure, for example, in the absence of horns and in the full dental formula. The fore-limbs are four-toed, the hind

[1] See especially Osborn and Wortman, *Bull. Amer. Mus. Nat. Hist.* vii. 1895, p. 333, and Osborn, *ibid.* viii. 1896, p. 157.

three-toed. It was intermediate between a Tapir and a Rhinoceros in size. It has been shown, too, from casts of the interior of the skull, that the cerebral hemispheres are much less convoluted than were those of *Titanotherium*.

Related to *Palaeosyops* is another primitive Titanothere, the genus *Telmatotherium*. This is also Eocene, from the Uinta Basin, the uppermost of Eocene strata. The skull of these creatures was rather elongated, and not unlike that of a Titanothere in general aspect. The dentition was complete and the canines not very large. The horns, which acquire so prodigious a development in the later Titanotheres, are just recognisable in at any rate many species of this genus *Telmatotherium*, the name being thus by no means an apt one. Better was that proposed by Dr. Wortman, of *Manteoceras* or "prophet-horned." The horns are small elevations upon the frontals just at the junction of these with the nasals, and, indeed, lying partly upon the latter bones. In *T. cornutum* the horns are chiefly borne upon the very long nasals, whose size contrasts with the same bones in the more highly-developed *Titanotherium*. It appears to be quite possible that *Titanotherium* was evolved from the genus *Telmatotherium*.[1]

SUB-ORDER 9. LITOPTERNA.

Whether the **Macraucheniidae** should be considered as a separate group of Ungulata is a matter of dispute. Cope placed them in a special order of Ungulates which he called Litopterna. Zittel, on the other hand, regards them as definitely Perissodactyles. One curious point of resemblance to existing Horses is shown—that is the presence of a pit in the incisor teeth. This matter seems to be so important as to need a placing of these forms in the neighbourhood of the Perissodactyles, even of the Equidae; it is so peculiar a character, and apparently so little related to any obvious similarity in way of life, that it seems to mark a special affinity. Not so the fact that in *Macrauchenia* at any rate the orbit was entirely surrounded by bone as in the Horse. We find that condition so frequently acquired in many groups,—a development from an earlier condition where the cavity for the lodgment of the eye is in continuity with the temporal

[1] See Osborn, *Bull. Amer. Mus. Nat. Hist.* vii. 1895, p. 82.

fossa, that it cannot be regarded as anything more than a mark of specialisation. It is, in fact, the case that the Macraucheniidae are in many points specialised, while retaining many primitive features of structure.

The chief primitive features are: the non-alternating positions of the wrist- and ankle-bones; these, of course, interlock in the Perissodactyles of to-day and in many extinct families. Then the absence of a diastema in the tooth series, coupled with the presence in *Macrauchenia* of a complete dentition. The small brain may be referred to the same category. *Macrauchenia* must have been a strange-looking animal. It walked upon three toes on each limb; the skull was Horse-like in general form, but the nostrils are removed to a point about as far back as in the Whales or nearly so, the nasal bones being correspondingly reduced. This it is thought argues a proboscis. The humerus is particularly compared by Burmeister[1] to that of a Horse. The radius and ulna though both well developed are fused. The neck is long, and, as in the Camel, the vertebral arteries run inside the neural arches. Since the fore-legs seem to have been rather longer than the hind-legs, though only very slightly, and the neck was long, the animal may have presented some likeness to the Giraffe. It is interesting to note that in the proportions of humerus to ulna this animal is more Lama-like than Horse-like. On the other hand, the proportions of femur to tibia are more Horse-like. The remains of the creature are limited to South America, and to quite superficial deposits. It is evidently a specialised type, and has pursued a course parallel to that of the Horse. Much nearer to the Horse however, but apparently by convergence only, is the genus *Thoatherium*, usually placed in a separate family, the **Protorotheriidae**. In this creature, which has many archaic characters, the toes are reduced to one in each foot. In an allied form, *Protorotherium*, we have the two lateral toes diminishing just as in *Anchitherium*.

[1] *N. Acta Acad. Caes. Leop. Car.* xxvii. 1885, p 238.

CHAPTER XI

UNGULATA (*continued*)—ARTIODACTYLA (EVEN-TOED UNGULATES)—SIRENIA

SUB-ORDER 10. ARTIODACTYLA.

THE Artiodactyle or "Even-toed" Ungulates are to be dis-

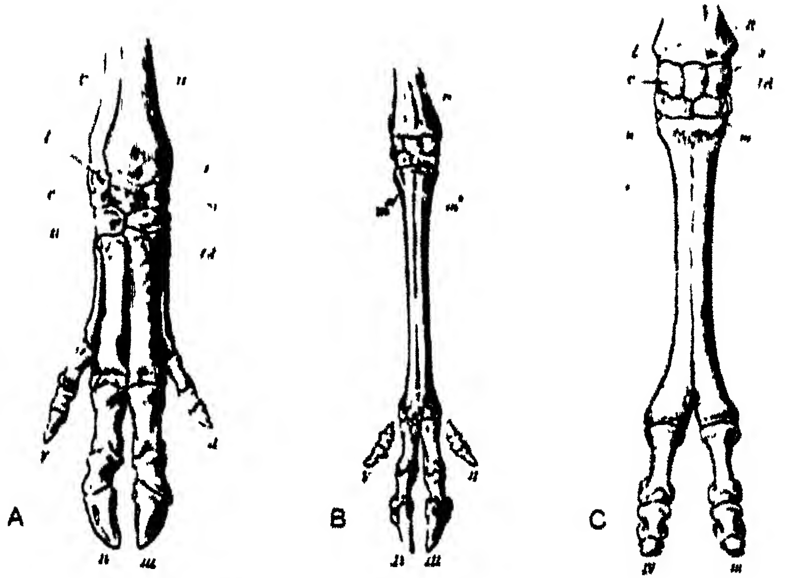

FIG. 138. Bones of the Manus **A**, of Pig (*Sus scrofa*), × $\frac{1}{3}$. **B**, of Red Deer (*Cervus elaphus*), × $\frac{1}{5}$. **C**, of Camel (*Camelus bactrianus*), × $\frac{1}{8}$. *c*, Cuneiform; *l*, lunar; *m*, magnum; m^2, m^5, second and fifth metacarpals; *R*, radius; *s*, scaphoid; *td*, trapezoid; *u*, unciform; *U*, ulna; *II*–*V*, second to fifth fingers. (From Flower's *Osteology*.)

tinguished from the Perissodactyla, and from other Ungulate groups, by a number of trenchant characters. The most salient

of these, and that which has given its name to the group, concerns the arrangement of the digits. Instead of there being but one prevailing digit—the third, in the hand and foot, through which the axis of the foot passes, there are two, numbers three and four, between which the same axis passes, and which are perfectly symmetrical with each other. This type of foot has been termed "paraxonic," as opposed to the "mesaxonic" Perissodactyle foot (see Fig. 121 B, p. 235). It has been attempted to prove that the single prevailing digit of the Horse's foot is a fused pair of digits, and the state of affairs which characterises the Camel, where the two metacarpals or metatarsals are to an almost complete extent united, has been urged in proof; so, too, certain abnormalities, such as those called "solid-hoofed pigs."[1] These latter are simply Pigs in which the two central metacarpals and the terminal hoofs are completely fused with one another. In some of such cases there is not the slightest trace of the union of the separate metacarpals and phalanges. Even the sesamoid bones, attached behind to the toes, are two in number instead of four. And, furthermore, the tendon supplying the bones is single, though showing traces of its double origin. Such Pigs often show the abnormality from generation to generation, and they proved convenient for those whose scruples would not allow them to eat the flesh of a beast "dividing the hoof" and not chewing the cud. More singular still, as showing a pathological approach from another side to the Perissodactyle condition in an Artiodactyle, is a calf, where the foot ended in three equi-sized digits, of which the middle one lay in the longitudinal axis of the limb. From the opposite side cases are known of a Horse with a split hoof and phalanges, thus presenting the most striking likeness to a Camel.

There is, furthermore, in certain groups of Artiodactyles (*e.g.* the Tragulidae) a tendency for the two middle metacarpals to unite, quite apart from such "sports" as those illustrated by the cases just set forth. And, as already mentioned, the union of the two middle metacarpals culminates in the Camel, Ox, etc. There is, however, absolutely no trace of such a fusion in the series of Perissodactyle animals known to us; and it would be by fusion rather than dismemberment that, as it would appear on this theory, the modern Ungulate foot has been arrived at. Of course

[1] See Bateson, *Materials for the Study of Variation*, London, 1894, p. 387.

the facts of Ungulate descent are absolutely destructive of any such comparisons.

As is the case with the Perissodactyles, the Artiodactyles show a historical series, the primitive five-toed condition being almost preserved in *Oreodon*, up to the most modern modification exemplified by the Ox, Sheep, etc., in which animals there are not even vestiges of the fourth and fifth toes. It has been stated, however, that the foetal Sheep has traces of those rudiments. The so-called cannon bone (the fused third and fourth metapodia) is accompanied in its fusion by an increase in length. At the same time the functional middle metacarpals push aside the rudiments and, forming a broad surface for that purpose, articulate with the magnum and unciform bones to the exclusion of the rudiments. This has been termed an "adaptive reduction." In the "inadaptive reduction" there is the same reduction of the metacarpals, but the rudiments still articulate as in the primitive Artiodactyle foot, *i.e.* Mc II with trapezium, trapezoid, and magnum; Mc III with magnum and unciform; Mc IV and V with unciform. This would appear to give greater solidity and consequently greater strength to the foot.

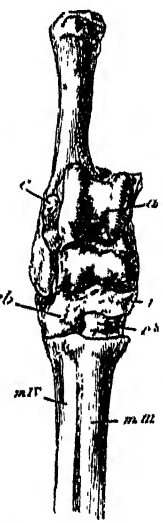

FIG. 139.—Dorsal surface of right tarsus of Red Deer (*Cervus elaphus*). ⅓. *a*, Astragalus; *c*, calcaneum; *c*³, cuneiform; *cb*, cuboid; *m III*, *m IV*, metatarsals; *n*, navicular. (From Flower's *Osteology*.)

The carpal bones of the Artiodactyla alternate in their articulation; the primitive state of affairs[1] is not retained even in the earliest types. The femur has no third trochanter, so prevalent in the Perissodactyles. In the hind-foot the calcaneum has an articular facet for the fibula, which is not characteristic of the Perissodactyla. In the more modern forms, *e.g.* the Cervidae, the navicular and cuboid become fused into one bone; and there are even further fusions which will be referred to later as characteristic features of different groups. It is interesting to notice that the reduction begins earlier and is clearer in the hind-foot than in the fore. One

[1] See, however, p. 196, for a discussion as to which *is* the more primitive arrangement.

can see how this may be purely adaptive, the push of the hind-legs in running needing a firmer support. In *Hyomoschus* this is the case. The hind-limbs are provided with a cannon bone, while the metacarpals of the fore-feet are still free.

The number of dorso-lumbar vertebrae is less in the Artiodactyle than in the Perissodactyle Ungulates. Whereas the former have but nineteen, the latter have, as a rule, twenty-three such vertebrae.[1] The number of ribs varies from twelve (*Camelus, Hydropotes*) through thirteen (*Cervus, Gazella*) to fourteen in *Dicotyles, Giraffa*, etc.

The curious form of teeth known as "selenodont" is characteristic of the Artiodactyla, though only found well developed in the modern forms, and of those only in the Pecora. The more primitive forms had "bunodont" teeth with typically four tubercles (if we except the tritubercular and but little-known *Pantolestes*); and the intermediate "buno-selenodont" type characterises such groups as the Anthracotheriidae.

While the stomach of the Perissodactyles is always a simple sac, it is complicated, or shows signs of complication, in the Artiodactyles. That of the Hippopotamus is divided into two chambers; there are three in *Tragulus*, and four in the typical Ruminants such as *Cervus, Ovis*, etc.

Had we to deal only with the still living genera of Artiodactyles, it would be easy to sort them into two groups on the characters of the teeth; for the Pigs and Hippopotamus are provided with tubercular molars; they are bunodont. The Deer, Camels, Oxen, Giraffes, etc., have selenodont molars. Besides, the latter are "Ruminants," and have a more complicated stomach. The existing Chevrotains forbid a more trenchant division, since they are, as will be pointed out in due course, somewhat intermediate in structure; the feet are more Pig-like, and the stomach is not so typically Ruminant. In any case such a division is prevented by certain extinct families which are perhaps ancestral to both. They have teeth which are not quite bunodont and not quite selenodont. These teeth have been termed buno-selenodont or buno-lophodont.

The distribution of the living Artiodactyles presents us with some interesting facts. The vast preponderance of species occurs in the Old World—34 in America as against over 250 species

[1] *Titanotherium* (see p. 266) is exceptional.

in Europe, Asia, and Africa The Neotropical region has no Oxen, or Sheep, or Antelopes. The latter are confined to Africa, Asia, and certain parts of the Palaearctic region; they are vastly more prevalent in Africa, where they take the place of the totally absent Deer The Pig tribe is almost entirely Oriental and Ethiopian in distribution, only one form, the European Wild Boar, ranging into the Palaearctic region; and the two species of Peccary are found in both North and South America. Broadly speaking, the Ethiopian region is the headquarters of the Artiodactyla. But the great island of Madagascar has but one form of Artiodactyle, a Pig of the genus *Potamochoerus*[1]

Group I.—*SUINA.*

Fam. 1. Hippopotamidae.—The family Hippopotamidae contains of existing genera only *Hippopotamus*, for the Liberian dwarf Hippopotamus is not now regarded, as it was formerly, as the type of another genus, *Choeropsis*. The reasons for its former separation were the loss of the outer pair of incisors and the different proportions of various parts of the skull. This little Liberian animal has, however, been shown by Sir W. Flower[2] to possess the missing incisors occasionally; and as to the proportions of the skull, it is exceedingly common for small animals to vary from larger relatives in this way. Hence, considering the characteristic features of the Hippopotamus and the fewness of species, it seems unnecessary to divide it up further. We shall therefore only recognise one genus.

The Hippopotamus at present is African in range, and confined to that continent. But quite recently it inhabited Madagascar; and further back still in time the existing African species, *H. amphibius*, ranged into Europe; there were also Indian forms, which were contemporary with the Stone-age man. The Common Hippopotamus is a great thick-skinned beast with but few hairs. It has four toes on each foot, a complex stomach, but no caecum. The strong incisors continue growing through life, as do the great canines. The number of incisors is two on each side of each jaw. Some of the extinct species had six in each

[1] Bones of *Hippopotamus*, however, indicate the very recent occurrence of that animal in Madagascar.

[2] "On the Pygmy Hippopotamus of Liberia," *Proc. Zool. Soc.* 1887, p. 612.

jaw, and they were distinguished as a genus *Hexaprotodon*, contrasting with *Tetraprotodon*, until intermediate conditions were observed. *Choeropsis*, as already observed, was a still further reduction of the tetraprotodont type. The molars (the formula is Pm $\frac{4}{4}$ M $\frac{3}{3}$) when worn show a double trefoil pattern. The orbital cavity is encircled by bone. As with many other aquatic mammals the kidneys are lobulated.

FIG. 140.—Hippopotamus. *Hippopotamus amphibius.* $\times \frac{1}{40}$

A very singular fact about the Hippopotamus is the production of a "bloody sweat," a carmine-coloured secretion, containing small crystals and corpuscles, from the skin. This coloured fluid has of course nothing to do with blood.[1]

The animal grows to a length of at any rate 14 feet. The limbs and the tail are short. Like other aquatic animals the nostrils are on the surface of the head, and can be closed when the animal is under water. When it reaches the surface of the water after a prolonged immersion, it spouts like a Whale. Sir Samuel Baker says that ten minutes is the longest time that the Hippopotamus can remain below the water. It is frequently a dangerous animal to encounter, as it will capsize boats, and even bite large pieces out of their bottoms; with its huge teeth it

[1] Tomes, *Proc. Zool. Soc.* 1850, p. 160.

can and does attack and destroy human beings. The Hippopotamus not only swims, but can walk along the bottom of a river with great rapidity. It occasionally puts out to sea from the mouths of rivers frequented by it; and it is supposed that in this way Madagascar was populated with Hippopotamuses, whose remains are now found in swamps in that island.

Fam. 2. Suidae.—The Pig family, Suidae, differ from the last in their smaller size, in the terminal nostrils and mobile snout, which is not grooved, except faintly as in *Babirusa*. They are generally hairy, but the Babyroussa is an exception, while *Phaco-*

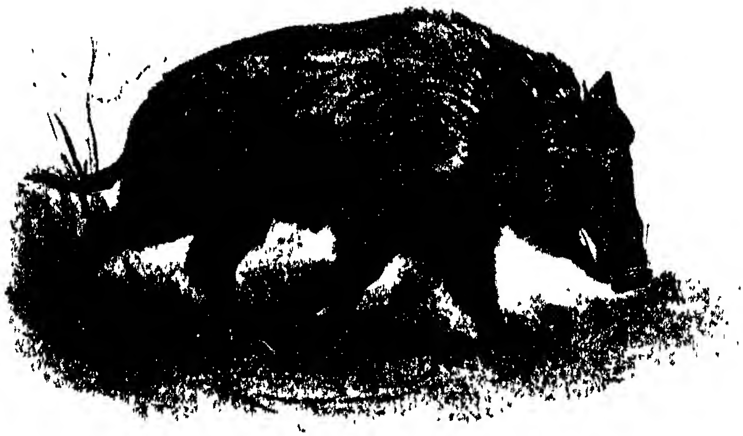

FIG. 141.—Wild Boar. *Sus scrofa*. × $\frac{1}{12}$.

choerus is but slightly haired. Though there are four digits, as in the Hippopotamus, only two reach the ground in walking. The stomach, furthermore, is simple, and (except in *Dicotyles*) there is a caecum. The kidneys are smooth, and the liver is more lobate than in *Hippopotamus*. The orbital cavity is confluent with the temporal fossa. The typical genus, *Sus*, is distributed over Europe, Asia, and the islands of the Malay Archipelago, reaching as far as Borneo and Celebes. The dentition[1] is complete. A single species, the so-called *S. sennaariensis*, is from Ethiopian Africa, but it is not certain how far this animal may be an escaped species introduced by man. A very large number of "species" of *Sus* have been described, but Dr. Forsyth

[1] There is, however, some doubt about the first premolars.

Major is disposed to reduce them to four if not to fewer species. He allows the widely-ranging *S. scrofa*, *S. vittatus*, and the eastern Malayan *S. verrucosus* and *S. barbatus*.

The Pygmy Hog of the Bhotans seems to be not entitled to specific rank, certainly not to generic (in the opinion of some), though it has been termed *Porcula salvania*.[1] The Wild Boar of

FIG. 142.—Pygmy Hog (from *Nature*). *Sus salvania*. × ⅛.

Europe is *Sus scrofa*. It was formerly quite abundant in this country; not merely are its remains exhumed from fens, caves and peat bogs, but there is ample evidence of its continuance down to a comparatively late historic period. Enactments are on record as to the hunting of these animals; there are places, such as Boarstall, whose names are clearly derived from the name of the animal, presumably once a native of the locality; and various documents all show the presence of the Wild Boar

[1] Dr. Garson has investigated its anatomy, *Proc. Zool. Soc.* 1883, p. 413, and states that its differences from *Sus* are "unimportant and few."

in this country down to so late a period as the end of the sixteenth century.

The African Wart Hog, genus *Phacochoerus*, is usually regarded

FIG. 143.—Wart Hog. *Phacochoerus aethiopicus*. $\times \frac{1}{8}$.

as the type of a distinct genus of Pigs. This animal, "superlatively ugly" with its huge tusks and great protuberances upon the face, is chiefly to be distinguished from the genus *Sus* by these characters, and by the complexity of the last molar, which, with the tusks, are sometimes in aged animals the only teeth left. The complete formula is Pm $\frac{2}{2}$ M $\frac{3}{3}$. There are two species of this genus, *P. aethiopicus* and *P. africanus*. When enraged the Wart Hog is said to carry its tail directly up, and to present a ludicrous as well as ferocious appearance.

FIG. 144.—Head of Wart Hog.

The Celebesian Babyroussa, genus *Babirusa*, is an almost hairless hog with enormously upturned tusks in both jaws of the

male. In the Wild Boar there is a hint of this, which is carried still further in *Phacochoerus*; but in *Babirusa* the upper tusks turn upwards before they leave the substance of the jaw, for which reason they appear to arise on its dorsal surface; the lower tusks are nearly as long. It has been found that the young of this Pig are not striped as are those of other Pigs. By means of the curved upper tusks this animal has been said by old writers to suspend itself to branches of trees, just as does by his downwardly-projecting tusks the male Chevrotain! There is but one species, *B. alfurus*.

From *Sus* proper the African and Malagasy *Potamochoerus*, including the Red River Hog, is barely separable generically. Their principal claim to generic distinction lies in the existence of a horny outgrowth arising from a bony apophysis above the canine in the male. These have been compared to the osseous "horn cores" in the extinct Dinocerata. But the Javan *Sus verrucosus* shows at least the beginning of a similar modification. The popular name of the animal is derived from the fine rufous colour of its pelage, not seen, however, in all the species. Dr. Forsyth Major[1] recognises five species, of which only one is from Madagascar.

Fam. 3. Dicotylidae.—The Peccaries are generally placed in

FIG. 145.—Peccary. *Dicotyles tajaçu*. × $\frac{1}{8}$.

a different family from that of the other Pigs. This family,

[1] "On the Species of *Potamochoerus*," *Proc. Zool. Soc.* 1897, p. 359.

Dicotylidae, contains but one genus, *Dicotyles*, with at most two species. The name of the animal is connected with the dorsal gland; the animal thus appeared to possess two navels. The Peccaries, exclusively confined to the New World, differ from the Old-World Pigs in one or more important characters. They have only three toes on the hind-feet, and the stomach is complicated. Though the Peccaries have but small tusks they hunt in packs and are very dangerous animals to meet with. They owe, too, their safety from many foes to their sociable habits. Being nocturnal animals they are liable to the attacks of the Jaguar, which will speedily overpower and devour a Peccary that has strayed from its herd.

Fossil Swine.—The existing genera of the Pig tribe are also known in a fossil condition. *Sus* itself goes back as far as the Upper Miocene. *Sus erymanthius*, the Erymanthine Boar, is known from beds of that age in Greece, England, and Germany. This genus is not known to have had a wider distribution in the past than it has in the present. *Dicotyles* occurs in the Pleistocene of both North and South America, the regions which it inhabits at the present day. The genus *Listriodon*, also Miocene, is remarkable for having lophodont instead of bunodont teeth, that is so far as concerns the molars, which resemble those of the Tapir. It was European and Indian in range. A number of genera, more remote from the existing Pigs than those which have just been dealt with, are placed together in a special sub-family, Achaenodontinae. The type genus, *Achaenodon*, had a somewhat short skull for a Pig; and it is in general aspect and in the characters of the canine teeth highly suggestive of that of a Carnivore. The bunodont molars, however, are Suine, as is the form of the lower jaw with a rounded angle. This is an Eocene animal found in Wyoming.

Elotherium[1] occurs chiefly in the Miocene of both North America and Europe; but *E. uintense* is Eocene. The orbits are completely encircled by bone in the more modern forms; this is not the case in the last-described genus, with which *E uintense* agrees. The skull is also longer and more Pig-like. The zygomatic arch is powerful, with sometimes a large descending process, such as is found in *Diprotodon*, more faintly in Kangaroos, and in Sloths and certain extinct Edentates. The lower jaw has a pair

[1] Marsh, *Amer. Journ. Sci* xlvii. 1894, p. 407.

of dependent processes near the symphysis, which suggest processes occupying a corresponding position in *Dinoceras.* The skull and body are heavy, but the two-toed limbs are slender. There is a smaller pair of toes behind these. The dentition is complete, and the canines are not inordinately developed The brain is very diminutive. Perhaps *E. uintense* should be separated as a distinct genus, *Protelotherium* [1]

Hyotherium (which is regarded as identical with *Palaeochoerus*) has a sharp sagittal crest; the orbit is nearly but not quite closed. The canines are not strongly developed. The upper canines have double fangs as in *Triconodon* among extinct mammals, and as in the Hedgehog and other forms among living Mammalia. The premolars have the cutting and serrated edge of those of some other Pigs, a feature which gives them a curious resemblance to the "grinding" teeth of Seals. The molars are tuberculate, and like those of living Pigs. It is European and Indian in range, and Miocene.

The genus *Choeropotamus* has a complete dental formula save for the loss of a premolar in the lower jaw. Though it has lost this tooth, it is from an older stratum than some of those forms which have retained that premolar; it has been found in the Upper Eocene of the Isle of Wight and of the neighbourhood of Paris.

The American and Miocene *Chaenohyus* has lost the corresponding teeth of the upper jaw.

Homacodon [2] is a genus consisting of several species, which has a bunodont and complete dentition. The molars are sextubercular in the upper jaw. *H. vagans* was of about the size of a Rabbit, and it appears to have had a curved neck. The limbs had five digits, as is so generally the case with Eocene Ungulates. It is known from the Middle Eocene of Wyoming.

GROUP II.—*RUMINANTIA.*

The Selenodontia or Ruminantia form the second division of existing Artiodactyles. The characters of the teeth, which give them their name, have already been referred to. They also differ in that there are never more than a single pair of incisors

[1] Osborn, *Bull. Amer. Mus. Nat. Hist.* vii. 1895, p. 102.

[2] Marsh, *Amer. Journ. Sci.* xlviii. 1894, p. 262.

in the upper jaw, and very usually there are none. As a general rule the third and fourth metacarpals and metatarsals become united to form a cannon bone. To this there is but one exception, the African *Hyomoschus*. Moreover, the second and fifth digits are nearly always rudimentary, and may practically disappear altogether. Here again the Tragulidae are an exception. The Ruminantia are so-called on account of the fact that they "ruminate," that is, after the food has been rapidly

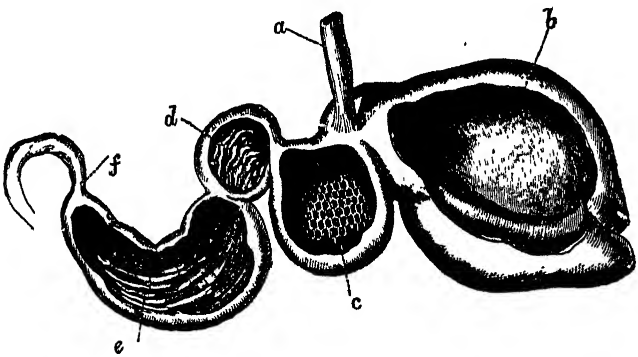

FIG. 146.—Stomach of Ruminant opened to show the internal structure. *a*, Oesophagus, *b*, rumen; *c*, reticulum; *d*, psalterium; *e*, abomasum; *f*, duodenum (After Flower and Lydekker.)

swallowed, it is forced back up the gullet and more thoroughly masticated. Associated with this is a complex stomach, which is divided into several compartments. This stomach has at least three compartments, as in the Tragulidae; but it has usually four. Its characters are illustrated in Fig. 146. The majority of the Selenodontia possess horns, which are partly formed of solid protuberances of the frontal bones. In the Giraffe they are somewhat different.

This group may be divided into—A. TRAGULINA, Chevrotains; B. TYLOPODA, Camels, Lamas; and C. PECORA, Deer, Antelopes, Oxen, Giraffes, Goats, Sheep.

A. TRAGULINA.

As the Tragulina are undoubtedly the most ancient of the Selenodontia it will be logical to commence with an account of them.

Fam. 4. Tragulidae.—This family comprises a number of small Deer-like animals, which are really in many points more related to the Pigs than to the true Deer. They are known as Chevrotains; and the term "Deerlet," introduced by Professor Garrod, is certainly appropriate, since they have the aspect of very small and hornless Deer. If it were not for their Artiodactyle feet one might at a glance confuse these creatures with some Marsupial type. The family is Oriental and West African in range. The two genera (whose individual peculiarities will

FIG. 147.—Indian Chevrotain. *Tragulus meminna.* × ¼.

be considered later) differ from other Artiodactyles in a number of rather important characters.

They are absolutely hornless in both sexes. The canines are present in both jaws, and are especially well developed in the upper jaw. The dental formula is I $\frac{0}{3}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{3}{3}$. In the skull the tympanic bulla is usually, as in the non-ruminating Artiodactyles, filled with loose bony tissue. The feet (usually) have the four toes of the Suina, and are therefore in a more primitive condition than in Deer and Antelopes. But as the middle metacarpals are fused in *Tragulus* (though separate in *Hyomoschus*) they are a stage further than are the Pigs, in the direction of the typical Ruminants.

The stomach is comparatively simple, thus offering inter-

mediate characters between the Pigs and the Ruminants; there are but three separate compartments. A highly-interesting character is afforded by the placenta. This is in the present family of the diffuse kind, not presenting the separated and tufted cotyledons of the Ruminant placenta. This we may fairly assume is a further proof of the less-specialised characters of this group[1] as compared with the Ruminantia, a view, however, which is not universally accepted. While the molars have the selenodont character of other Pecora, the premolars are more adapted for cutting, with sharp edges.

The genus *Tragulus* consists of several species (e.g. *T. stanleyanus*, *T. napu*, etc.), which have been aptly compared in external appearance to certain Rodents such as the Agoutis. The legs are delicate and slender, hardly "thicker than an ordinary cedar pencil." These creatures have got among the Malays a considerable reputation for astuteness, embodied in the saying, "Cunning as a *kanchil*." The male has tusks, which greatly contributed to the confusion of this creature with the totally different Musk Deer, *Moschus moschiferus*. It is even said to suspend itself by their aid to the branches of trees, and so avoid danger.

Hyomoschus (or *Dorcatherium* as it should properly be called) is West African. Its rich brown colour, with spots and stripes, is much like that of the Chevrotains, but it has shorter limbs. The only species is *D. aquaticum*, which is sometimes called, on account of its frequenting the banks of streams, the Water Chevrotain. Remains of this genus occur in Miocene and Pliocene strata of Europe.

The separate metacarpals, comparatively simple stomach, absence of horns, diffuse placenta, and spotted pelage are features which argue the primitive position of these animals among existing Artiodactyles.

Besides the two existing genera which have just been treated of, there are a number of extinct genera undoubtedly belonging to the same group.

Gelocus (Eocene and Oligocene in range) is a European genus known from France. It differs from the living members of the group by the fact that the second and fifth toes on both hind- and fore-feet are represented, as in certain Deer,

[1] For the structure of *Tragulus*, see Milne-Edwards, *Ann. Sci. Nat.* (5) ii. 1864, p. 49.

by rudiments at the upper and at the lower end only; they are deficient in the middle. The middle large metacarpals, though closely applied, are not fused. The metatarsals, on the other hand, are, or are not fused, according to the species. A later form is the genus *Leptomeryx* from the Miocene of North America. This genus departs from the typical Traguline structure in more than one point. The tympanic bulla is hollow instead of being filled with cancellated bone; the cuneiform is not fused with the cuboid and navicular, though the latter are with each other; the lateral digits of the hind-feet are rudimentary. The magnum and trapezoid, however, are fused. In the fore-feet the middle metacarpals are separate, and the lateral less perfect metacarpals have toes. The metatarsals are fused.

Not definitely referable to the Tragulidae, but coming near to them, are the **Protoceratidae**. Of this family there is but one well-known genus, *Protoceras*,[1] from the Miocene of North America.

The skull is singularly reminiscent of *Dinoceras*, with which this quite Artiodactyle genus has, of course, nothing to do. It merely exemplifies the phenomenon of "parallelism." In general form it is peculiarly long and low. There are three pairs of bony protuberances: one, the largest, pair are situated on the maxillae rising up just behind the implantation of the canine teeth; the parietals have a second pair; and a third much more diminutive pair of bosses are upon the frontals, near their junction with the nasals. This description refers to the male; the female has only traces of the parietal bosses. These were all possibly tipped or sheathed with horn or roughened skin. The dentition of this genus is precisely that of the Tragulidae, *i.e.* I $\frac{0}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{3}{3}$. The orbit is completely encircled by bone; the auditory bulla is not swollen; the premaxillae are small.

The nasal cavity is very large and open, the end of the nasal bones anteriorly being situated at about the middle of the skull; this would seem to indicate at least a flexible and long nose like that of the Saiga Antelope, if not a trunk.

The brain was of good size, and quite well convoluted.

The limbs are constituted on the Traguline plan; in the fore-limbs the middle metacarpals are quite free from each other, and the more diminutive lateral digits are complete. The meta-

[1] Marsh, *Amer. Journ. Sci.* 1897, p. 165.

tarsals are free, but with a tendency to fusion; the lateral toes are only represented at the upper extremity. The carpal bones are separated.

This animal, which was about the size of a Sheep, though of more delicate proportions, was allied not only to the Tragulidae but to the Giraffidae, it is impossible to refer it definitely to either family.

B. TYLOPODA.

Fam. 5. Camelidae.—This small group of Selenodonts includes only the Camels and Lamas. The limbs are long and have no traces of the second and fifth toes The fused metacarpals and metatarsals diverge somewhat at their distal ends. In the upper jaw is a single pair of incisors The stomach differs from that of the typical Ruminants. The rumen has smooth and not papillose walls, and from it are developed the "water cells," diverticula with narrow mouths provided with a closing sphincter muscle. The psalterium is reduced to a mere vestige, and so the stomach has, as in the Tragulina, but three chambers. This, so far ancient, character in the structure of the Camel tribe is associated with another, also seen in the more primitive Ungulates, viz. the diffuse character of the placenta. A very singular peculiarity of this group is the fact that the blood corpuscles instead of showing the ordinary mammalian round contours are elliptical.

The genus *Camelus*, confined to the Old World, is made up of two quite distinct species, the Bactrian Camel, *C. bactrianus*, with two humps, and the Dromedary, *C. dromedarius*, with only one. The former species is Asiatic. It is a singular fact that neither of the species is known to occur in a genuinely wild condition. The so-called "wild" Camels appear to be invariably feral. The two species will interbreed; and there is at the Zoological Society's Gardens such a hybrid, which has the general appearance and shaggy brown hair[1] of the Bactrian animal, but the one hump of the Dromedary. It may be that the Bactrian Camels of Lob-nor are really wild; but the desert contains so many remains of cities destroyed by sand-storms that these reputed wild

[1] This is the winter dress. In the summer both camels lose their long rough hair.

Camels may be the descendants of animals belonging to the inhabitants of those cities. A strayed herd of Camels has established itself in a feral state in Spain. Otherwise the genus does not occur in Europe. The Camels are also represented in the New World. The genus *Lama* (*Auchenia* of many authors) belongs to this family. These Camels differ from their allies in the Old World by their smaller size, by the absence of the characteristic hump, and by the dropping of one premolar, the dental formula

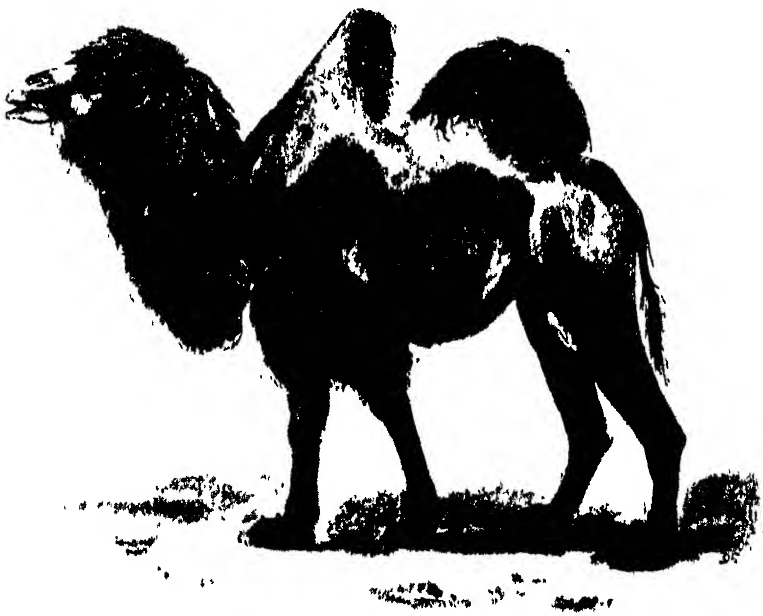

FIG. 148. Bactrian Camel. *Camelus bactrianus*. $\times \frac{1}{30}$.

being otherwise similar. A variety of names, Lama, Alpaca, Huanaco, Vicuña, have been applied to these animals; but it appears that the names are in excess of the number of the species. Mr. Thomas, who has lately inquired into the matter, will only allow two, the Huanaco, *Lama huanacos*, of which there are two domestic races, the Llama and the Alpaca, and the Vicuña, *Lama vicugna*. They are both South American in range. Not only is there a herd of escaped Camels in Spain, but the Spaniards attempted to introduce and acclimatise the useful Lama. The first Lama ever seen in Europe was brought in the year 1558 to

the town of Middelburg in Holland; it was purchased and presented to the Emperor of Germany. Gesner gives a curious figure of it, representing the animal as a comparatively colossal beast submitting itself to the guidance of a dwarfish man. The habit of "spitting" of the Lama is well known. Augustin de Zarate and Buffon speak of the Lama as having no protection save this habit, which is more than a mere ejection of saliva: the contents of the

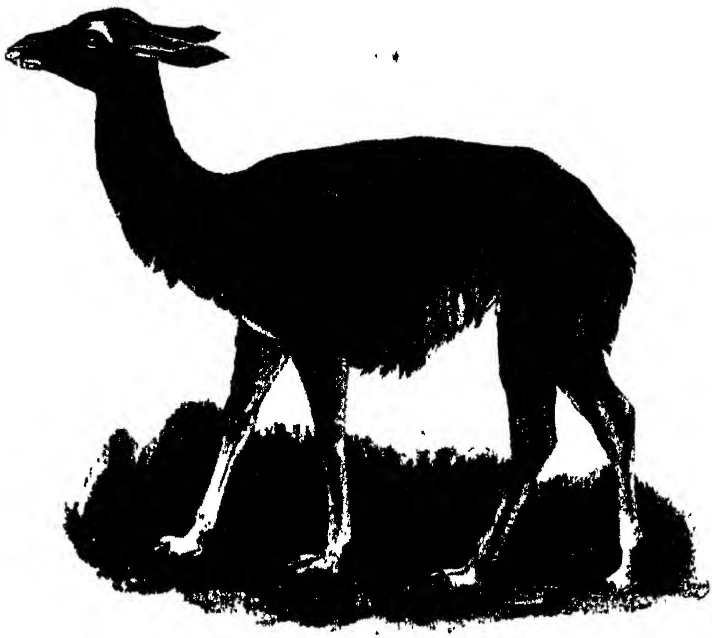

FIG. 149.—Lama. *Lama huanacos* × $\frac{1}{15}$.

stomach are forcibly shot at the object of its annoyance. It can also kick and bite. In the intestines (as in those of some other mammals) are found Bezoar stones, or Bezards as they are variously spelt. These were once valued in medicine, and even so lately as 1847 were, according to Gay, the historian of Chili, in vogue; these concretions, comparable to the ambergris of the Whales, were supposed to be an antidote to poison.

Extinct Camels.—The earliest cameloid type is the genus *Protylopus*,[1] of which we are acquainted with an imperfect skull

[1] See Wortman, *Bull. Amer. Mus. Nat. Hist.* x. 1898, p. 93.

and the greater part of a radius and ulna belonging to one individual, and most portions of the hind-limbs in other specimens The one species, *P. petersoni*, was about the size of a "jack rabbit," and is late Eocene (Uinta formation) and American in range The teeth of this mammal are the typical forty-four, and the canines are not pronounced, being incisiform in shape. In the skull the nasals overhang, as in the genus *Poebrotherium* The orbit is not closed by bone. There is in this ancient Camel a trace of the supra-orbital notch so characteristic of the Camel tribe. "The vertebrae resemble those of the modern Lamas closely in their general proportions." The lumbars have the usually Cameloid formula of 7 This genus has but two functional toes on the hind-

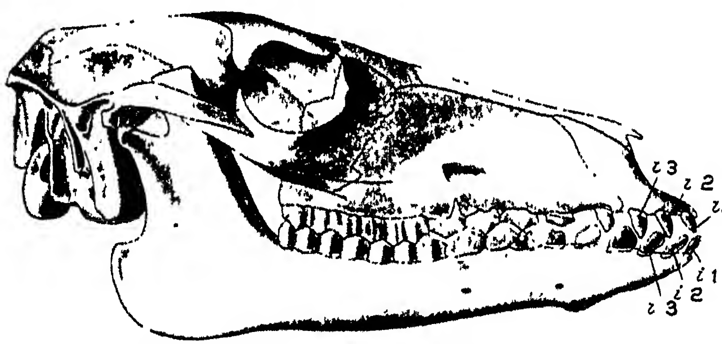

FIG. 150.—Skull of *Poebrotherium wilsoni*. I^1, I^2, I^3, Incisors 1-3. × ½ (After Wortman.)

feet, the second and fifth being reduced to vestiges. It is interesting to note that the radius and ulna appear to remain distinct, except in very old animals, in which they come to be co-ossified in the middle only, thus foreshadowing their complete union in the next genus, *Poebrotherium*. The present genus, moreover, as well as *Poebrotherium*, was distinctly unguligrade; it has not acquired the characteristic phalangigrade mode of progression of the modern types of Camels.

The American and Oligocene *Poebrotherium* has been recently and exhaustively studied by Professor Scott.[1] It was considerably smaller than a Lama. Its neck was long as compared with other Artiodactyles, but still shorter than that of the Lama. It was a lightly-built, graceful creature, with apparently some external likeness to a Lama. It is an important fact to notice that at this

[1] "Osteology of *Poebrotherium*," *Journ. Morph.* v. 1891, p. 1.

period, and for a long time after, there were no types referable to the Camelidae in the Old World. Though a Camel in many features of its organisation, *Poebrotherium* was "generalised" in many ways. Thus the metacarpals and metatarsals were not fused to form a cannon bone, and the two lateral digits were represented by splint rudiments of metacarpals and metatarsals. The dentition was complete. The skull though distinctly Tylopodan, also shows more generalised characters. Thus the orbit is not quite, though nearly, completed by bone. In the Camel it is quite closed. The nasal bones are much longer, reaching nearly to the end of the snout The odontoid process of the axis vertebra is not spout-like as in existing forms, but cylindrical, though slightly flattened upon the upper surface. The scapula is described as being more like that of the Lama than of the Camel, though variations occur which approximate to the Camel. The brain, judging of course from casts, has those sulci "which are common to the whole series of Ungulates, and closely resemble those of a foetal Sheep."

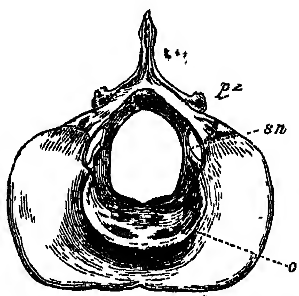

FIG. 151.—Anterior surface of axis of Red Deer. × ⅔. *o*, Odontoid process; *pz*, posterior zygapophysis; *sn*, foramen for second spinal nerve. (From Flower's *Osteology*.)

Later in historical sequence than *Poebrotherium*, and structurally intermediate between it and *Protolabis*, is the Miocene genus *Gomphotherium*. It shows an advance in structure upon *Poebrotherium*, in that the orbit is completely encircled by bone, though the posterior wall is thin; the lower canines instead of being incisiform are curved back as in later Camels, and separated by a wide diastema from the preceding and the succeeding teeth.

Later in age than *Poebrotherium* is *Protolabis*, a Tylopod in which the full number of teeth is still retained; its skull presents no particular changes from the Poebrotherine type; the nasals, however, are somewhat shortened.

Later still in point of time is *Procamelus*. In this form we have apparently an ancestral stock, whence both Camels and Lamas were derived. The upper incisors are as in existing forms, but the first and second persist for a somewhat longer time. The skull shows two well-marked types of structure; in *P. occidentalis*

there are more points of likeness to the Lama, in *P. angustidens* to the Camel. In both, the orbits are completely encircled by bone. The nasals are much shortened. The odontoid process of the axis is still more concave than in *Poebrotherium*, but not spout-like as in existing forms. This fact shows that the spout-like character of the Camels' odontoid process is not a point of affinity to other Artiodactyles—in fact the occurrence of the same form of odontoid process in Perissodactyles is enough proof of this. We must come to the conclusion that the form is adaptive in all cases. If we were not obliged on palaeontological evidence to come to this conclusion, the structure in question is just one which would be fastened upon as evidence of genetic affinity; for it is a resemblance in a small though distinctive point of structure having no obvious relation to utility. The metacarpals and metatarsals have coalesced to form the cannon bones, though a rudiment of one metacarpal seems to remain. The genera referred to appear to be on the direct line of descent of the modern representatives of the family. But there are other forms which are offshoots of the main stem. Such are *Homocamelus*, *Eschatia*, and *Holomeniscus*. The last two are Pliocene and American: the teeth are much reduced.

C. PECORA.

The Pecora are a group which possess so many characters in common that it is not an easy task further to subdivide them.

In all there are but two functional digits on the feet, and the metacarpals and metatarsals of these are fused. There are no upper incisors, and canines in the upper jaw are not universal, and generally small. Horns are confined to this group of the Selenodontia.[1] The premolar teeth are of a simpler form than the molars. The stomach has four chambers, of which two may be regarded as belonging to its cardiac half and two to the pyloric. The former are, in the first place, a large paunch or rumen, followed by a smaller reticulum, so called on account of the network arrangement of the folds of its lining membrane. Connected with the latter, and constituting the first part of the pyloric half of the stomach, is the psalterium or "manyplies," so called on account of the longitudinal folds, like the leaves of a

[1] Unless *Protoceras* (see p. 284) was furnished with horns.

book, into which its lining membrane is raised. Finally there is the abomasum, out of which proceeds the small intestine. Garrod has observed that the chamber of the stomach which varies most among the Pecora is the psalterium. This chamber is specially large in *Bos*, and particularly small in the Antelopes *Nannotragus* and *Cephalophus*. But its variation relates more especially to the folds of its mucous membrane. These folds are of varying lengths and have a definite arrangement There may be as many as five sets of laminae of regular depths. The most simple psalterium is that of *Cephalophus*, where there are only two sets of laminae of different sizes, a deeper set and a very much shallower set; this form is termed by Garrod "duplicate." Most common is the "quadruplicate" arrangement, with four sets of laminae of differing depths. In all Pecora the liver is but little divided by fissures.

Fam. 6. Cervidae.—The Deer tribe is a very extensive one, and, with the exception of Africa and Australia, world-wide in distribution.[1]

The Deer are absolutely distinguished from all other Ruminant animals by the existence of antlers, which are invariably present in the male sex, save in the aberrant genera *Moschus* and *Hydropotes;* in the Reindeer alone are antlers present in both sexes. The general characters of these appendages have been dealt with on a former page (p. 200), where they are compared to, or rather contrasted with, the horns of the Bovidae. These antlers, so characteristic of the Cervidae, are very variously developed among the members of the family. Thus in *Elaphodus* the antlers are very small and entirely unbranched. In the Muntjacs, *Cervulus*, the antlers are hardly larger, but they have a small anterior branch arising from near the pedicel, the "brow tine." In *Cariacus antisiensis* only one branch, the brow tine, is present, but it is nearly as long as the main stem of the antler, the "beam." In *Capreolus capraea* the beam bears two tines; in *Cervus sika* three; in *C. duvauceli* two of the three tines present bear secondary branches. There are other complications (some of which are illustrated in Figs. 152-157) of the simple antler which culminate in the complex antlers with their expanded "palms" of the Elk and the Fallow Deer.

[1] Sir Victor Brooke, "On the Classification of the Cervidae," *Proc. Zool. Soc.* 1878, p 883.

Another highly-interesting fact concerning these same antlers is their gradual increase in complexity of tines and palm from the Miocene *Cervus matheroni* to the great Irish Elk of post-Tertiary times.

Beyond the antlers there seems to be no character of universal applicability which distinguishes the Cervidae from the nearly-related Antelopes. There are, however, a number of structural features which are *nearly* universally characteristic. Excepting *Moschus* (which Professor Garrod would not allow to be a "Deer"), no Cervine has a gall-bladder[1] to its liver. All Bovidae (including Antelopes) have, with the exception of *Cephalophus*.

A small but constant character of the Deer is the existence of two orifices to the lachrymal duct. The genus *Tragelaphus* alone among Antelopes shows this character.

So far as is known the placenta of the Deer has but few cotyledons, that of the Bovidae many. But not many types are known.

The navicular, cuboid and ectocuneiform are often united. This is never the case in the Bovidae.

The first and second phalanges of the lateral (imperfectly developed) digits are always present except in the Muntjacs, they are never found in Bovidae. The Deer always present a light brown to a darker brown coloration. *Elaphodus michianus* is almost black. There is commonly white on the under parts and beneath the short tail. Some Deer, such as the Fallow Deer, are spotted; and the young of others that are uniformly coloured when adult are spotted. In some cases a winter coat, darker than the summer coat, is developed.

Altogether some sixty species of Deer are known, of which the preponderance are Old-World forms. The Deer of the Old World are distributed among the genera[2] *Cervus* (all Europe and Asia); *Cervulus*, the Muntjacs (India, Burmah, China, etc.), *Hydropotes* (Eastern China); *Capreolus* (Europe and Central Asia); *Elaphodus* (Eastern China); there is one American *Cervus*, the Wapiti. The American genera are *Cariacus* and *Pudua*. The Elk (*Alces*) and the Reindeer (*Rangifer*) are circumpolar. The principal structural modification which occurs within

[1] It has been occasionally recorded in an Axis Deer, and in another species, *Cariacus superciliaris*.

[2] It is not every one that admits so many genera. I follow Sir Victor Brooke.

the family Cervidae concerns the rudimentary fifth and second toes. In *Capreolus, Hydropotes, Moschus, Alces, Rangifer*, and *Pudua* there are considerable remains of the lower parts of metacarpals II. and V.; in the other genera smaller traces of the upper ends of the same bones.

The two most abnormal genera are *Moschus* and *Hydropotes*, more particularly the former, which neither Sir V. Brooke nor Professor Garrod allow to be members of the family at all. *Moschus* is usually placed in a special sub-family by itself, Moschinae, the remaining Deer being referred to another sub-family, Cervinae.

Sub-Fam. 1. Cervinae.—The genus *Cervus* comprises rather over twenty existing species, which, except the Wapiti (*C. canadensis*), are exclusively Old World in distribution. The principal features of variation in the genus, in accordance with which it has been divided up into sub-genera, are (1) palmated (Fallow Deer, *Dama*) or non-palmated antlers; (2) adults spotted with white at all ages and seasons (*Axis*), or in summer only (*Pseudaxis*), or not at all; (3) spotted or unspotted young; (4) existence or absence of rudimentary canines in the upper jaw.

Among the members of this genus, *Cervus* (*Elaphurus*) *davidianus* is interesting as having been first observed by the missionary Père David in a park belonging to the Emperor of China near Pekin. Its horns are remarkable for dividing early into two branches of equal length, of which the anterior again branches into two. Specimens of this Deer were ultimately obtained for the Zoological Society's Gardens.

The species of *Cervus* are fairly distributed between the Palaearctic and the Indian regions. The Palaearctic species, such as Luhdorff's Deer (Fig 152), are mainly Asiatic *Cervus elaphus* and *Cervus dama* alone are European and British. The former of course is the Red Deer, the latter the Fallow Deer. The Red Deer is reddish-brown in summer and greyish-brown in winter, with the white patch on the rump so common in the Deer tribe. The Red Deer is genuinely wild in Scotland, in certain parts of Devonshire and Westmoreland, and in the New Forest. At the beginning of the last century, according to Gilbert White, there were 500 head of deer in Wolmer Forest, which were inspected by Queen Anne. The antlers may have as many as forty-eight points; and a stag with more than the three anterior tines is termed a "Royal Hart." The Fallow Deer has

palmated antlers, and is usually spotted. It seems to be an introduced species, common report pointing to the Romans as the introducers. It would be more correct to say "re-introduced," for fossil remains of this Deer have been met with.

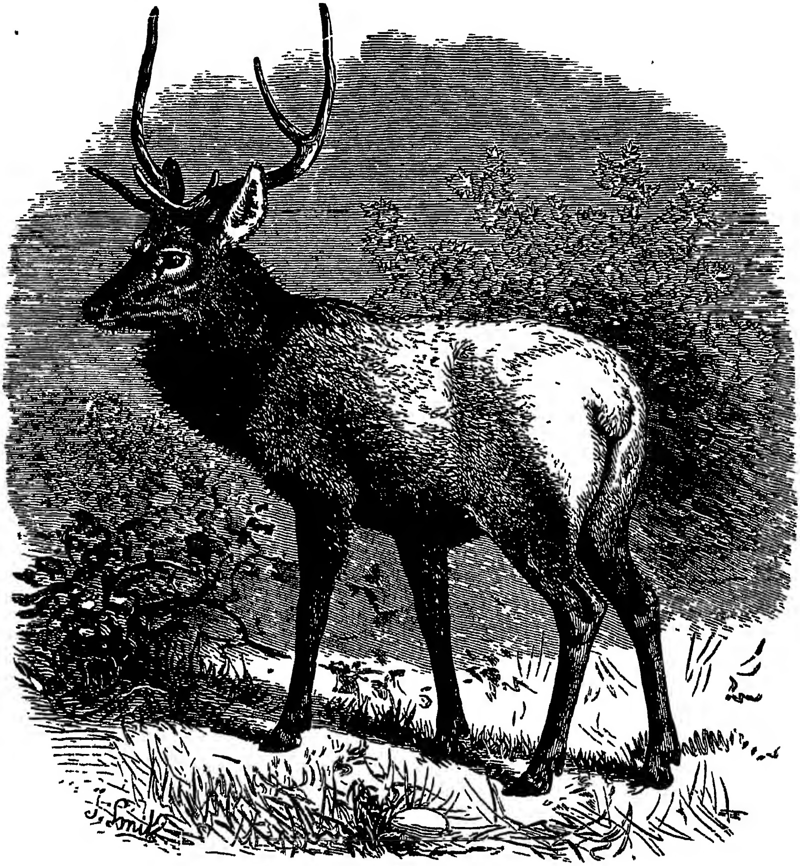

Fig. 152.—Luhdorff's Deer. *Cervus luehdorffi.* × $\frac{1}{15}$. (From *Nature.*)

Elaphodus[1] contains probably two species, *E. cephalophus* of Milne-Edwards and *E. michianus* of Swinhoe, both from China. The antlers are small and unbranched; the canines in the male are massive; it differs from *Cervulus,* to which it is closely allied, principally in the absence of frontal glands. The second

[1] Garrod, "On the Chinese Deer named *Lophotragus michianus* by Mr. Swinhoe," *Proc. Zool. Soc.* 1876, p. 757.

species has a dark iron-grey pelage, and the late Mr. Consul Swinhoe described it as very Goat-like in aspect.

Capreolus.—The Roe Deer has fairly complex antlers. It is a small Deer and has spotted young. The common Roe Deer, *C. capraea,* is a native of this country. It is the smallest of our Deer, and its antlers only have three tines in stags of the third year. It is a singular fact about this Deer that though the pairing season is in July and August, the young are not born until the following May or June, a period which does not represent that of gestation. The germ remains dormant for some time before developing.

The Muntjacs, *Cervulus,* form a distinct generic type confined to the Indian and the South-Eastern Palaearctic region. They

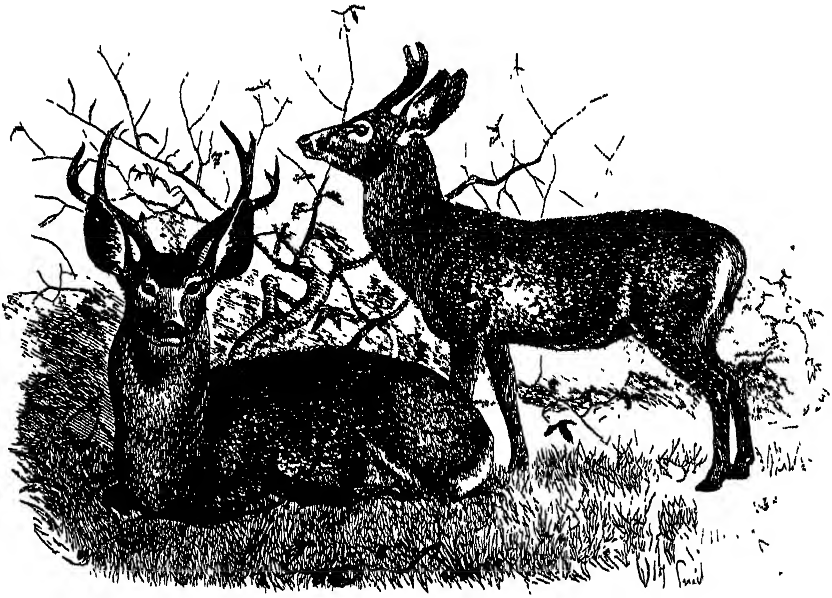

FIG. 153.—Mule Deer. *Cariacus macrotis.* × $\frac{1}{15}$. (From *Nature*.)

are small Deer with spotted young, and short one-branched antlers placed upon pedicels as long as themselves. The canines are strongly developed in the males. There are about half-a-dozen species.

Cariacus is exclusively American in range, and contains about twenty species. There are or are not upper canines. The young

are spotted. The antlers are occasionally very simple; in *C. rufus* and a few allies (placed in a special sub-genus *Coassus*) they are simple spikes without branches. In this genus, and in the nearly allied and also New-World *Pudua*, the vomer is prolonged backwards and divides the posterior nares into two. The bulk of the species are South American.

FIG. 154.—Chilian Deer. *Cariacus chilensis*. × $\frac{1}{12}$. (From *Nature*.)

Pudua, just mentioned, comes from the Chilian Andes. It is a small Deer without canines and with minute antlers. Other generic names have been proposed for various species of American deer.

Hydropotes inermis is a small perfectly hornless Deer, living on the islands of the Yang-tse-kiang. The male has tusks; the young are spotted. Though, like other deer, *Hydropotes* has no gall-bladder, both Mr. Garrod[1] and Mr. Forbes[2] found the rudi-

[1] *Proc. Zool. Soc.* 1877, p. 789.

[2] *Proc. Zool. Soc.* 1882, p. 636.

ments of one in the shape of a white ligamentous cord. Mr. Forbes has especially dwelt upon the likeness of the brain to that of *Capreolus*. The female has four teats, and produces three to six young at a time.

FIG. 155.—Water Deer. *Hydropotes inermis*. × 1/15. (From *Nature*.)

Alces machlis, the Elk or Moose, is a circumpolar species with palmated antlers and is of large size. The young are unspotted. This animal is the largest of the Deer tribe. The aspect of this creature is by no means that of a Deer, the long, thick, and rather prehensile upper lip not by any means suggesting the family to which it belongs; the legs, too, are ungainly through their unusual length. The Moose has a curious method of protecting himself from Wolves. Instead of moving about during heavy snowstorms, and being thus on the heavy ground an easy prey for these agile enemies, the animal forms what is known as a "Moose yard." An area of ground is kept well

trampled down, and the animal contents itself with browsing upon the adjacent stems. The well-trampled ground gives an easy footing, and by his powerful horns the great stag is able to keep his enemies at bay

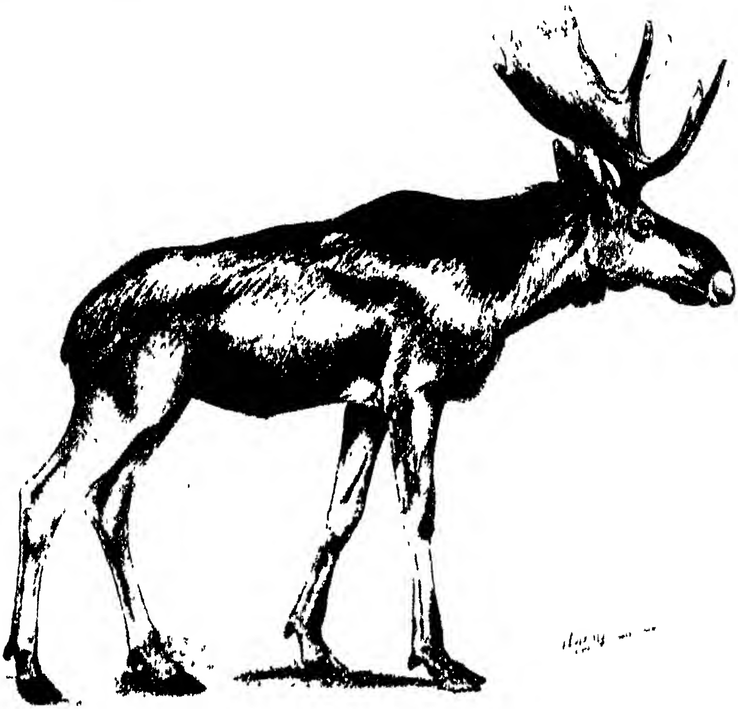

FIG. 156. Moose. *Alces machlis.* × $\frac{1}{20}$.

Rangifer tarandus, the Reindeer, is unique among Deer by reason of the fact that both sexes wear antlers. These antlers are palmated. The brow tine and the next or bez tine are also palmated and are directed forwards and a little downwards. The young are unspotted. The pelage alters in winter. Like the Moose, the Reindeer is circumpolar. As is well known, during the Pleistocene period the Reindeer extended its range as far as the South of France. Even in the historic period it is said to have been hunted in Caithness.

Reindeer, like so many other particularly Arctic animals, have regular migrations. In Spitzbergen, for instance, the animal migrates in the summer to the inland region of the island, and in

the autumn back again to the sea coast to browse upon the seaweed. These migrating herds have been stated to be led by a large female.

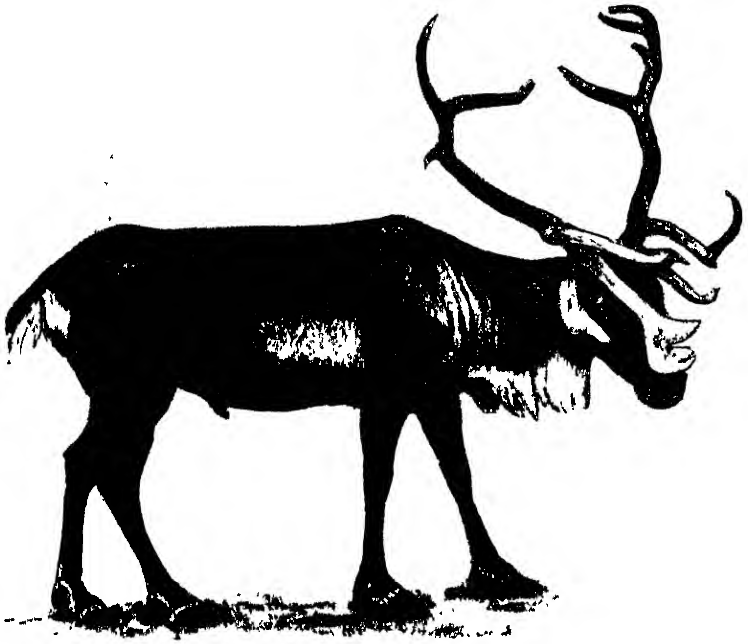

FIG. 157.—Reindeer. *Rangifer tarandus.* × $\frac{1}{16}$.

Sub-Fam. 2. Moschinae.—*Moschus moschiferus*[1] is a native of the Asiatic Highlands. It is 3 feet or so high, perfectly hornless, and with very large canines in the male. It is noteworthy that in *Hydropotes,* where the canines are also very large, horns are absent. These are examples, perhaps, of correlation. The musk sac (whence the name) is present on the abdomen of the male only. There is no crumen or suborbital gland, which is so generally (though by no means universally) present in Cervidae. But the male has, in addition to the musk glands, glands near the tail and on the outside of the thigh. Unlike other Deer, the lachrymal bone of *Moschus* bears but one orifice. The feet, so far as concerns the preservation of the outer rudimentary

[1] Sir W. Flower "On the Structure and Affinities of the Musk Deer (*Moschus moschiferus*)," *Proc. Zool. Soc.* 1875, p. 159; Garrod, *loc. cit.* 1877, p. 287; and F. Jeffrey Bell, *Proc. Zool. Soc.* 1876, p. 182.

metacarpals, are of the more ancient type represented in *Alces*, *Hydropotes*, etc. A gall-bladder is present. The young, as in so many Cervidae are spotted; but the adult is of a greyish-brown colour.

FIG. 158.—Musk Deer. *Moschus moschiferus.* × ⅛. (From *Nature.*)

There is no doubt that *Moschus* is more nearly related to the Cervidae than to any other Ruminants. It is regarded by Sir W. Flower as "an undeveloped deer—an animal which in most points (absence of horns, smooth brain, retention of gall-bladder, etc.) has ceased to progress with the rest of the group, while in some few (musk gland, mobile feet) it has taken a special line of advance of its own."

The musk itself, which gives its name to the creature, is found in a gland on the belly, about the size of a hen's egg. The whole gland is cut out and sold in this condition. Such quantities of musk deer have been and are killed for this purpose that the rarity of the animal is increasing. In the seventeenth

century it was so common that the traveller Tavernier purchased 7673 musk "pods" in one journey, or, according to Buffon, 1663. The tusks, which recall those of *Hydropotes*, to which *Moschus* is not nearly allied, and of *Tragulus*, with which it has of course still less connexion, are said to be used for the digging up of roots. Its feet, in relation to its mountain-ranging habits, are very mobile.

Extinct Species of Deer.—It has been already mentioned that the most primitive kinds of Deer had no horns at all, resembling in this the modern *Moschus* and *Hydropotes*, and that with lapse of time went hand in hand an increasing complexity of antler; the facts of palaeontology harmonising in the most striking manner with the facts of individual development from year to year. The oldest forms seem to be more nearly akin to the living Muntjacs, and their remains occur in the lowest Miocene beds of both Europe and America. At present the group is confined to the warmer parts of Asia and some of the islands belonging to that continent.

One of the oldest types is *Amphitragulus*. This genus, which consists of several species, inhabited Europe, and differed from living Muntjacs in being totally hornless in both sexes; the skull had no lachrymal fossa or deficient lateral ossification.

Nearly allied is *Dremotherium* of similar age and range.

The Middle Miocene has furnished the remains of the genus *Dicroceras*. This is the earliest Deer in which horns have been found. The horns are, as the name of the genus implies, bifid, and have, like those of the living Muntjac, a very long pedicel. This is also a European genus like the last. From this period we come across true Deer, which commence in the Upper Miocene and have branched horns. Moreover they belong, at least for the most part, to the existing genera. One of the most remarkable forms is *Cervus sedgwicki* (sometimes placed in a separate genus, *Polycladus*) from the Forest Bed of Norfolk and from the Upper Pliocene of the Val d'Arno. This creature was remarkable for its multitudinously-branched antlers. These end in no less than twelve points. No Deer exists or has existed in which the horns are so completely branched. They are like those of a Red Deer exaggerated.

Fam. 7. Giraffidae.—Undoubtedly the type of a distinct family, Giraffidae, is the genus *Giraffa*. It is characterised by

the long neck, which, nevertheless, consists of only the normal seven vertebrae, and by the "horns" which differ from those of all other Ruminants; they are small bony prominences of the frontal

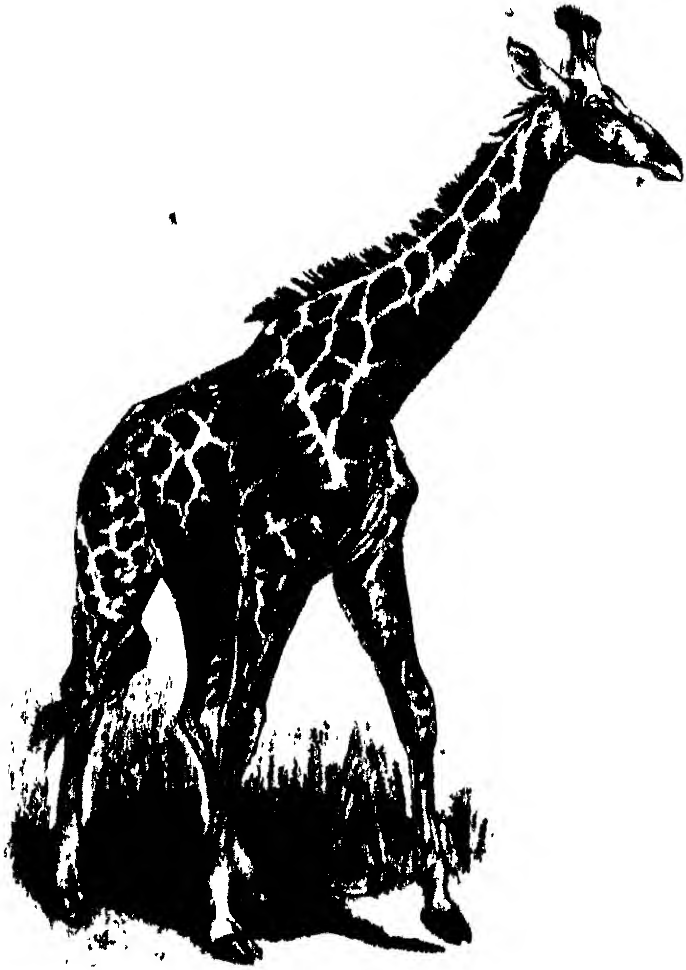

FIG. 159.—Giraffe. *Giraffa camelopardalis.* × $\frac{1}{40}$.

bones, which become fused with the skull, and which are covered with unmodified skin. They are not shed. Between them is a median prominence. This cranial armature is present in the female as well as in the male, and is well developed even in the

new-born young. The orbits are completely encircled by bone, and there is no lachrymal fossa, so common in Deer and Antelopes. There are no canines above; but these are present in the lower jaw. The rudimentary digits of other Ruminants have disappeared in this genus. There are fourteen pairs of ribs as in many other Artiodactyla. The liver of the Giraffe[1] is, as in many, but not all, Ruminants, devoid of a gall-bladder; neither has it a caudate or a Spigelian lobe. The caecum is actually largish ($2\frac{1}{2}$ feet in length), but is relatively very small, as the small and the large intestines measure 196 and 75 feet in length respectively. The Giraffe has a well-marked "ileo-caecal" gland, found in many Ruminants; its appearance in *Giraffa* is especially compared by Garrod with its appearance in *Alces*.

Considered by itself, *Giraffa* forms a very isolated type of Ruminant. But after we have dealt with certain facts concerning extinct forms clearly allied to *Giraffa*, the isolation of the family will be found to be less marked.

The Giraffe ("one who walks swiftly," the word means in Arabic) is, as every one knows, limited in its range to the African continent. It is not, however, so familiar a fact that there are two quite distinct species of Giraffe, one a northern form from Somaliland, and the other South African. The distinctness of these two, *G. camelopardalis* and *G. australis*, has been lately worked out in some detail by Mr. de Winton.[2] The principal point of difference between them consists in the large size of the median horn in the Cape species, which is represented by the merest excrescence in the other species. The Giraffe of West Africa is held to differ from the northern and southern species, coming nearer to the former. It appears in the first place to be a larger animal, and slight differences in the skull have been pointed out. This series of peculiarities may be expressed, for those who do not object to trinomial nomenclature, by calling this novel western form *Giraffa camelopardalis peralta*. The existence of the three horns covered with unaltered skin is the main characteristic of this Ungulate. But the Giraffe also differs from other Artiodactyles by its enormously long neck, which enables it to browse upon trees inaccessible to the common herd

[1] For the viscera, see Garrod, *Proc. Zool. Soc* 1877, p. 5, etc.; and *ibid.* p. 289, etc.

[2] *Proc. Zool. Soc.* 1897, p. 273

of Ruminants. The neck is often supposed to have some relation to this method of feeding. But a more ingenious explanation of its inordinate length is that it serves as a watch-tower. The long grass of the districts inhabited by the animal swarms with Lions and Leopards, which must be foes. The long neck allows of a wide look out being kept, and it is noteworthy that the Ostrich, living under similar conditions, is also renowned for its length of neck. It is the spots upon the Giraffe which have given it its name of Cameleopard; these spots present in the southern form a series of chocolate-coloured areas, sharply marked off by white spaces. Of these spots it is asserted that they serve as a means of concealing their possessor. Sir Samuel Baker[1] wrote of it in the following words: "The red-barked mimosa, which is its favourite food, seldom grows higher than 14 or 15 feet. Many woods are almost entirely composed of these trees, upon the flat heads of which the giraffe can feed when looking downwards. I have frequently been mistaken when remarking some particular dead tree-stem at a distance that appeared like a decayed relic of the forest, until upon nearer approach I have been struck by the peculiar inclination of the trunk; suddenly it has started into movement and disappeared."

The Giraffe, remarked Pliny, "is as quiet as a sheep." The Roman public, to whom the first Giraffe ever brought into Europe was exhibited, expected from its name "to find in it a combination of the size of the camel and the ferocity of a panther." As a matter of fact, Giraffes in captivity are not always sheep-like in temper. They will kick with viciousness and vigour, and will even initiate an attack upon their keeper. At the same time they are singularly nervous creatures, and have been known to die from a shock. In moving, the Giraffe uses the fore- and hind-limb of each side simultaneously; this gives to its gait a peculiar rocking motion, the singularity of which is heightened by the curving movements of the long neck, which even describes now and then a figure of eight in the air. *Giraffa camelopardalis* and the species (?) already referred to are the only existing Giraffes (of the genus *Giraffa*), and they are not found out of Africa. Sir Harry Johnston has lately given a brief account of a larger and more brilliantly coloured species from Uganda

[1] *Wild Beasts and their Ways*, 1890, p. 151.

which will probably prove to belong to a distinct genus. It has five horns, the additional pair being placed above the ears.

Sir Harry Johnston has quite recently made known another genus of Giraffidae living in the Semliki forest, Belgian Congo district. The skin and two skulls, as well as the bones of the feet, are known from specimens sent by Sir Harry Johnston to the Natural History Museum, and briefly described to the Zoological Society by Professor Ray Lankester.[1] This creature, of which the native name is "Okapi," is proposed to be called *Ocapia johnstoni.* The first actual specimens which reached this country were two bandoliers made from the skin of the flanks, which were striped black and white, and were not unnaturally held to be portions of the skin of a new species of Zebra. The animal is of about the size of a Sable Antelope, and the back and sides are of a rich brown colour, it is only the fore- and hind-limbs which are striped, the striping being longitudinal, *i.e.* parallel with the long axis of the body. The head is Giraffe-like, but there are no external horns; wisps of curled hairs seem to represent the vestiges of the horns of other Giraffes. The tail is rather short, and the neck is rather thick and short. The skull is clearly Giraffine. The basicranial axis is straight, and the fontanelle in the lachrymal region is very large. Upon the frontal bones near their parietal border is a large boss on either side, which presumably represents the horn core or "os cornu." On the mandible the great length of the diastema between the incisors and premolars is a Giraffine characteristic. The Okapi lives in pairs in the deepest recesses of the forest.

We are acquainted with a few extinct forms, belonging to *Giraffa*, which are extra-African in range. *G. sivalensis* is from the Pliocene of the Siwalik Hills in India, *G. attica* from Greece. These remains, however, do not include the top of the skull, so that it is doubtful whether their horns were as in *G. camelopardalis*.

A closely-allied genus is the extinct *Samotherium.* This flourished in Miocene times, and its remains have been found in the Greek island of Samos. The neck and limbs are shorter than in the Giraffe, and the horns, longer than in *Giraffa,* are placed just above the orbit upon the frontal bones alone, instead of upon the boundary line of frontals and parietals as in *Giraffa.* In several ways, therefore, the existing Giraffe is a more modified or

[1] See also Sclater, *Proc. Zool. Soc.*, 1901, ii. p. 3.

specialised animal than its forerunner of the Miocene. In the latter, the male alone carried horns, and in neither sex does the unpaired median bony excrescence appear. The remains of this genus (probably even the same species, *S. boissieri*) also occur in Persia.

Helladotherium (there is but one species, *H. duvernoyi*) has its four limbs of nearly the same length; the skull of the only known example is hornless; the neck is shorter than in *Giraffa* It is known from the Miocene deposits of Pikermi in Greece

Palaeotragus is a genus which is not referred to the Giraffidae by all systematists. Its very name, given to it by the eminent French palaeontologist M. Gaudry, indicates his opinion as to its Antelopine affinities. The chief and indeed (according to Forsyth Major[1]) the only reason for placing this Ruminant with the Antelopes is the large size of the horns. They undoubtedly suggest the horn cores of Antelopes. But they are placed wider apart than in those animals. It is thought that the hornless *Camelopardalis parva* is the female of this species, which is from Pikermi

Rather more different from *Giraffa* is the extinct genus *Sivatherium*, from the Siwalik deposits of India. Here again there has been some discussion as to its affinities. Some place it in the neighbourhood of *Antilocapra*, but most palaeontologists now regard it as a Giraffe. The main peculiarity of this large beast was the existence of two pairs of horn cores; the larger are upon the parietal bones, and are of a palmated form, with a few short tines, which are highly suggestive of those of the Elk (*Alces*). The shorter anterior pair are upon the frontal bones. The neck is short, the limbs of equal length, and there are no additional toes upon the limbs. *Sivatherium* was almost as large as an Elephant, and in restorations it is depicted as having a fleshy dilated nose like the Saiga Antelope; this view is based upon the position and size of the nasal bones. Hornless skulls have been identified as the female of *Sivatherium*.

Vishnutherium, *Hydraspotherium*, and *Bramatherium* are allied genera.

Fam. 8. Antilocapridae.—This family contains but one genus and species, the N. American "Pronghorn," *Antilocapra americana*. This animal deserves a family to itself on account of the singular structure of the horns, which are intermediate in character

[1] Forsyth Major, *Proc. Zool. Soc.* 1891, p. 315.

between those of the Deer and those of the Antelopes. They are unquestionably "hollow-horned" Ruminants, in that there is an osseous horn core, upon which lies the actual horn. This, however, is softer than in Bovidae, and is semicorneous. It is, indeed, more like the velvet of the stag's horn. Moreover the horn is branched, and there are sometimes even three prongs. Furthermore, it is now certainly known that the Pronghorn sheds its horns not merely occasionally, but with definite annual periodicity. It so far resembles the Deer. But it must be borne in mind that in the Deer the horn shedding is a twofold process. There is first of all the stripping off of the velvet, and secondly the shedding of a portion of the horn core down to the burr. What happens in the Prongbuck is the shedding of the true horn only (= the shedding of the velvet), *not* of the horn core. It appears, however, that occasionally (once in their lifetime?) certain undoubted Antelopes may cast their horns.[1] Another external character of this animal is the total absence of "false hoofs," the last vestiges of the second and fifth digits. The Pronghorn is a gregarious creature running in bands of six up to hundreds.

Fam. 9. Bovidae.—This family, more extensive than that of the Cervidae, contains not only the Oxen, Sheep, and Goats, but also the Antelopes, save only *Antilocapra*, which must be placed in a family by itself. The only two points which distinguish all Bovidae from all Cervidae[2] are the nature of the horns already described, and the polycotyledonary condition of the placenta. Moreover the horns are usually present in both sexes, though there are exceptions, such as the Sheep and Goats, and various genera of Antelopes (*Tragelaphus, Tetraceros,* etc.). There are never the first two phalanges belonging to the rudimentary digits II., V., as there are in all Deer excepting *Cervulus*. There is as a rule but one orifice to the lachrymal duct. There are never persistent upper canine teeth in either sex.

It is exceedingly difficult to separate the Antelopes from the Sheep, Oxen, and Goats. Their inclusion along with these creatures in one family, Bovidae, shows that no differences of an important character exist. The term Antelope is rather of popular than

[1] "On the Shedding of the Horns in the Prongbuck," see Bartlett, *Proc. Zool. Soc.* 1865, p. 718; Canfield, *ibid.* 1866, p. 105; Murie, *ibid.* 1870, p. 334; and Forbes, *ibid.* 1880, p. 540.

[2] The distinction between the two families has been called "fanciful." It may be admitted that it is not great.

of zoological significance. As a rule there are horns in both sexes; but this rule is not without exceptions, of which one is the genus *Strepsiceros*, the Koodoo. Many other Bovidae are horned in the males only, e.g *Saiga*, *Tragelaphus*. The Antelopes further differ from the true Oxen in their more graceful build, and in the fact that the horns, if they curve at all, generally curve backwards towards the neck. In the Oxen, on the other hand, the build is stouter, and the horns usually curve outwards. The same remarks apply to the Sheep. Such an Antelope, however, as the Eland (*Orias*) is very Ox-like in habit. Another feature which may be remarked upon, though not of absolute differential value, is that while the Antelopes are as a rule smooth and sleek in their skins, the Oxen tend to be rough and shaggy. The Zebu, however, in this, in its hump, and in general aspect, is far from being unlike an Eland. But then the Zebu is a domestic race, and we do not know what the wild stock was like. It is perhaps with the Goats that the Antelopes have the nearest affinities, and it is difficult to place such a form as *Nemorrhaedus*, and indeed some others. In the Antelopes as a rule the middle lower incisors are larger than the lateral ones; in the Sheep and Goats they are alike in size. The parietal bones, too, in the Antelopes are moderately large and are much shortened in the remaining Cavicornia, especially in the Oxen. As the Antelopes are the oldest, so far as we know, of all bovine animals, one would expect to find them combining the characters of the rest. But they do this so effectually that a disentanglement is really impossible. They date from the Miocene. Antelopes are now limited to Europe, Asia, and Africa, they have always had the same range, though more abundant in former times in Europe. They preponderate now in tropical Africa, and abound in genera and species. Messrs. Sclater and Thomas[1] allow altogether thirty-five genera, of which twenty-four are exclusively Ethiopian in range.

In the following summary of the group Messrs. Sclater and Thomas's work is followed. They commence with a section or sub-family of which the type is the Hartebeest.

Bubalis, or *Alcelaphus* as it is sometimes called, is an African genus, ranging however into Arabia. These Antelopes are characterised by the long skull and the doubly-curved horns. There are eight species of the genus, of which *B. caama* is the

[1] *The Book of Antelopes*, London, Porter, 1894-1900.

best known; this is the animal known as the Hartebeest. The Bontebok and Blessbok belong to a closely-allied genus, *Damaliscus*, distinguished mainly by the fact that the bony base of the horn cores is not extended upwards, and therefore the parietal bones are visible when the skull is viewed from in front, which is not the case in *Bubalis*.

The Gnus, *Connochaetes*, are familiar owing to their curious aspect. The hairy face, and rump and tail like those of a pony

Fig. 160.—Brindled Gnu. *Connochaetes taurinus*. × $\frac{1}{20}$.

are highly characteristic. The horns are bovine in appearance, standing outwards and then curving upwards.[1] There are three species of Gnu, all from South Africa. They are *C. gnu*, *C. taurinus*, and *C. albogulatus*.

Of the Cephalophine section there are two genera:—

Cephalophus is an African genus. These animals are known as Duikerboks; they are small, and have short non-curved horns in the male sex only. Their general aspect is not unlike that of certain Deer with simple horns, such as *Cervulus*. Messrs. Sclater and Thomas allow thirty-eight species. The

[1] They are straight in the young.

smallest species do not exceed the dimensions of a Hare. None are really large.

Tetraceros is an Indian genus characterised, as its name denotes, by the fact that it possesses four horns. It is the posterior pair which correspond to the single pair of *Cephalophus*. The anterior pair, which are much smaller and are sometimes absent, are a new pair. The female of this Antelope is hornless. Sheep are occasionally four-horned, and there is indeed a breed of such in Kashmir. A four-horned Chamois was described by the late Mr. Alston.

The Klipspringer, *Oreotragus saltator*, is the first type of a third section; as its name denotes, it is an Antelope with Goat-like habits, being found particularly among rocks. The horns are short and straight. This, the only species of the genus, is African in range, of which its Dutch name gives evidence. A specimen in the Zoological Society's Gardens (as has been pointed out to me by Mr. Mercer) had the habit of depositing the secretion of the tear gland upon a mass of concrete in its enclosure, the secretion thus exuded forming a pointed heap of hardish matter. It may be that the object of this is to guide its fellows to its whereabouts.

Ourebia is a less-known genus, larger in size, but with horns of the same character, though longer.

The Grysbok and the Steinbok, genus *Raphiceros*, have similar horns. This as well as the last two genera have horns in the male only.

One of the smallest of Antelopes belongs to an allied genus; this is *Neotragus pygmaeus*. It is known as the Royal Antelope, a name apparently derived from Bosman's statement that the negroes called it "the king of the harts." Its horns are very small. The height of the animal is only 10 inches. Horns are present in the male alone. The last three genera are African.

The Cervicaprine series, which is also African, includes the Waterbucks and Reedbucks, so called on account of their water-loving propensities. As in the last series, from which they are separated by Sclater and Thomas, but with which they are united by Flower, there are horns in the male only. These horns, though not twisted, are long. The typical genus is *Cobus*, of which there are eleven species. The Waterbuck, *C. ellipsiprymnus*, and the Sing-sing, *C. unctuosus*, are perhaps the best-known species; the former is

blackish grey, the latter browner in colour. In *C. maria* and one or two other species the horns are more curved backwards and again forwards than in some of the others, where their form is sublyrate.

The Reedbucks, *Cervicapra*, are closely allied to *Cobus;* they are, however, of smaller size. Here, as in that genus, the females are hornless, and the horns of the males are of medium size. Five species are referred to the genus. They are all of a brownish fawn colour. A genus *Pelea*, with but one species, *P. capreolus*, has been separated on account of the fact that the horns are nearly straight and that there is no naked patch of skin beneath the ears. This animal has received its name on account of its resemblance to the Roebuck.

The Antilopine section includes a number of genera.

The genus *Antilope* is Indian in range. It includes but one species, *A. cervicapra*. This Antelope is of medium size, with a brown pelage getting blacker with years; it is thus known as the Black-buck. The female, which is hornless, is lighter brown. The horns are long, spirally twisted, and closely ringed.

Aepyceros, with two species, is African. The Palla (*Ae. melampus*) is a large Antelope, with longish lyrate horns in the male, which are half-ringed.

The Saiga Antelope, genus *Saiga*, is one of the most remarkable types of Antelope in its outward appearance. Its nose is very large and inflated, the two nostrils being quite widely separated, a depression indeed lying between them dorsally. The horns are lyrate in the male, absent in the female. The "ovine expression" of this bovine animal is more pronounced in the female. Corresponding with the clumsy nose are very short nostrils, the commencement of the narial aperture being therefore very far back. It is almost suggestive of *Macrauchenia* in this respect The fleece is also Sheep-like. The genus occurred in this country during the Pleistocene. It is now an inhabitant of Eastern Europe and Western Asia. The only species is *S. tartarica*.

The Chiru, *Pantholops*, is allied to the Saiga. The horns of the male are long and nearly straight; they are ringed in front. The muzzle is swollen in the male, the nostrils are large, and provided with extensive sacs internally. The colour of this animal, which is exclusively Thibetan in range, is a pale fawn. The hair, in accord with its habitat, is very woolly. No living specimens have ever been brought to Europe. This creature has accumulated much

legend. Its blood is believed by the Mongols to possess virtues, and by means of the rings on the horns fortunes are told. Naturally the animal is on these grounds hard to stalk and shoot.

The Gazelles, genus *Gazella*, are fairly numerous in species, which are both Palaearctic and Ethiopian. There are altogether twenty-five of them. The genus as a whole is characterised by the small or moderate size, the sandy coloration with white belly,

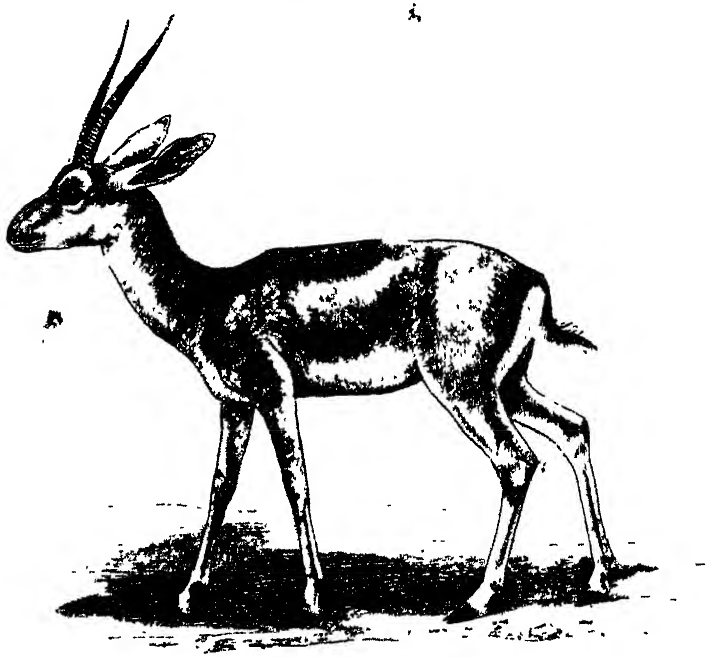

FIG 161 —Loder's Gazelle. *Gazella loderi.* $\times \frac{1}{10}$

the presence of dark and light stripes on the face and on the flanks. These streaks, however, are not always present, and their presence or absence serves to differentiate some of the species. The horns are usually present in both sexes. The horns are of fair length, ringed, and of lyrate form.

The Springbok is separated from the rest of the Gazelles, to which genus it is clearly most nearly related, as a genus *Antidorcas*. This genus differs from *Gazella* by having only two lower premolars as in *Saiga*. Otherwise it resembles the Gazelles; there is but a single species, *A. euchore*, which is African.

Ammodorcas is closely allied to the Gazelles, but differs from them in having an elongated neck and also a long tail. *A. clarkei*, the only species, is limited to Somaliland.

Lithocranius, not unlike the last, has a still longer neck, which makes it almost Giraffe-like; its tail, however, is short The scientific name is derived from the "solid stony character of the cranium." In running, this Gazelle carries the head forward in a straight line with the body. It is African.

Dorcotragus with one species, *D. megalotis*, is a pigmy Gazelle restricted to Somaliland. Its likeness, on account of size and in some other superficial features, to the Klipspringer, led to its original confusion with that genus (*Oreotragus*).

A sub-family Hippotraginae, or Hippotragine section, includes

FIG. 162.—Sable Antelope. *Hippotragus niger*. $\times \frac{1}{20}$. The horns of the specimen figured have not nearly reached their full dimensions.

a number of Antelopes which agree in the possession of four mammae, and of molars more like those of the true Oxen, of

horns of some length, present in both sexes, and of a longish tail. They are all African in range.

The type genus *Hippotragus* has its horns placed above the orbits; they are not twisted, but curved backwards. There are three species in the genus. Of these the best known is *H. niger*, the beautiful Sable Antelope. Its general colour is a rich, dark, glossy brown with white stripes on the face, and with a white belly. The other species are the Roan Antelope, *H. equinus*, and the Blaaubok, *H. leucophaeus*, of which the last specimen was probably killed in 1799.[1]

The genus *Oryx* (chiefly African, but also Arabian and Syrian)

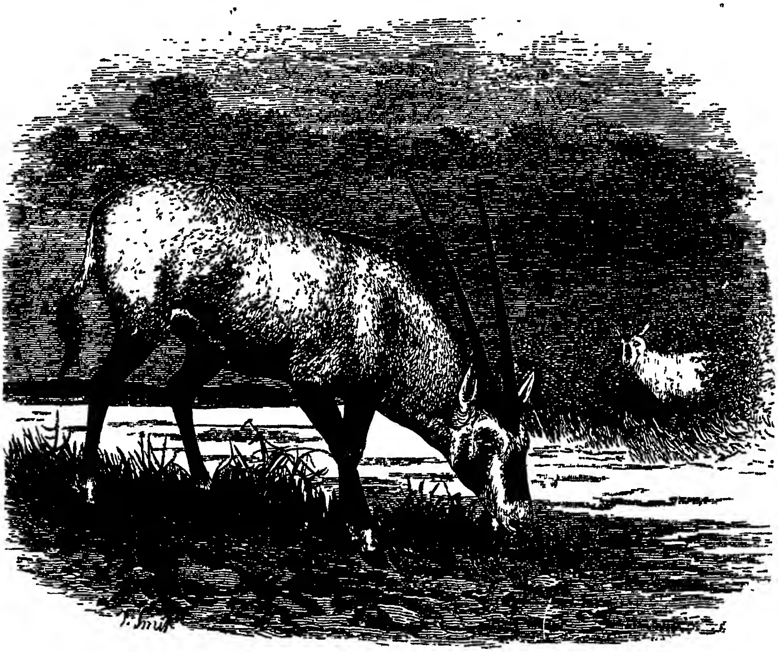

FIG. 163.—Beatrix Antelope. *Oryx beatrix*. × 1/18. (From *Nature*.)

also contains a number of species, which are fairly familiar through the fact that several of them are always on view in the Zoological Society's Gardens. The genus differs from *Hippotragus* in that the horns, present in both sexes, are placed behind the orbits, and slant backwards in a line with the face. They are annulated. The Leucoryx (*O. leucoryx*) is of a pale colour, but

[1] W. L. Sclater, *The Fauna of South Africa*, *Mammals*, i. 1900.

this is not so marked as in *O. beatrix*, which is largely white with, however, brown legs. The Gemsbok is a handsome creature with greyish tawny colour, much darker on the legs, and with a Gazelle-like, dark, side stripe It has received its vernacular name on account of its supposed likeness to the Chamois ("Gemse"), just as the Rehbok was so-called from its supposed likeness to the Roe Deer, and the Eland to the Elk. The Beisa (*O. beisa*) is of a similar tawny colour to the last, and also with darker stripes.

The Addax (*Addax*) of North Africa, Arabia and Syria, has but one species (*A. nasomaculatus*). The horns are spirally twisted.

The Tragelaphine section includes the Kudus, Elands, Nilgais,

FIG. 164.—Speke's Antelope. *Tragelaphus spekii* (♀). × $\frac{1}{15}$.

and Harnessed Antelopes. They are all long-horned (when the horns are present in both sexes), the horns being twisted; the nose is naked with a slight median groove, and all are Ethiopian or Oriental in range.

The genus *Tragelaphus* includes the Harnessed Antelopes, so called on account of the direction of the stripes suggesting harness. The females are hornless, and the colours of the two sexes are different The hoofs are long and the toes rather unusually separable, which state of affairs is in accord with the

swampy country affected by many. *T. gratus* and *T. spekei* are larger forms; the Boschbok, *T. sylvaticus*, is smaller.

The Kudus, genus *Strepsiceros*, have more markedly twisted horns, which are absent in the female. The body is vertically striped with white. The largest species is *S. kudu*; a smaller form, *S. imberbis*, is from Somaliland.

The last genus of this section or sub-family is the African Eland, genus *Oreas*[1] (which it appears should be spelt *Orias*). The Elands

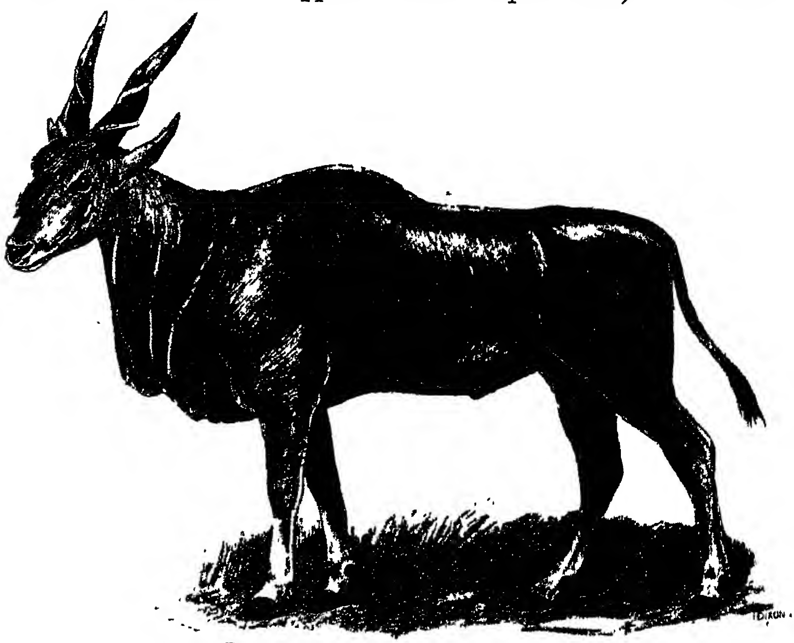

FIG. 165 —Eland. *Orias canna*. × $\frac{1}{25}$.

are perhaps more Ox-like in appearance than the other members of this group, and in both sexes have horns, in which the spiral twisting is more close. *Orias canna* is the name of the common Eland. *O. livingstonii* has been applied to an East African variety, which has thin and faint lateral stripes like the other members of the group to which it belongs.

The genus *Boselaphus* includes only *B. tragocamelus*, the Nilgai, which is purely Indian in range. The female is hornless, and the horns of the male are smooth and not long.

[1] *Taurotragus oryx* has unfortunately been discovered to be the correct name for the Eland.

The members of the Bovine section or Oxen are to be distinguished from other hollow-horned Ruminants by their stouter build and by the fact that the horns stand out from the sides of the skull and are simply curved, not twisted; and smooth, not annulate like those of other Ruminants. The muffle is naked, broad, and moist. The Oxen are widely distributed; but are entirely absent from the Australian region and from South America and Madagascar.

The true Oxen are perhaps best considered to form but a single genus, *Bos*. They have, however, been divided into a number of genera. Even the supposed aberrant *Anoa depressicornis* of Celebes hardly differs sufficiently to warrant its separation. In favour of this view, too, is the extraordinary ease with which different "genera" will cross with each other and produce fertile offspring. The following is the pedigree of an animal lately living in the Zoological Society's Gardens. The female offspring of a male Zebu and a female Gayal was mated with a male Bison. The female calf was again mated with a Bison and produced a calf, also a female, which contained therefore the three species, *Bos indicus*, *Bibos frontalis*, and *Bison americanus*. It is clearly unwise in view of this fact to insist too much upon generic distinctions in any of those types.[1]

Of this genus the Oriental Gaur (*Bos gaurus*), the Gayal (*B. frontalis*), and the Banteng (*B. sondaicus*) form a well-marked section, characterised by their dark coloration and by the somewhat flattened horns.

The Gaur, *Bos gaurus*, has a more concave forehead than its allies; the horns are less curved than those of the Banteng, and less so than the horns of the Gayal (*Bos frontalis*). It inhabits the Indian Peninsula; and extends through Burmah to the extremity of the Malay Peninsula. The Malay name of this animal is Sakiutan, which simply means wild cattle. It chiefly frequents wooded hills and is an excellent mountain climber.

Bos frontalis, the Indian Gayal, has a white caudal disc like the last species, but the forehead is flat and the horns curve but little. It is chiefly known as a tame animal, and its occurrence in the wild state has been doubted. It has furthermore been suggested that it is merely a tame race of the Gaur altered

[1] A. D. Bartlett, "On some Hybrid Bovine Animals bred in the Society's Gardens," *Proc. Zool. Soc.* 1884, p. 399.

slightly through domestication. It is, however, said not to cross in a state of nature with the Gaur[1]

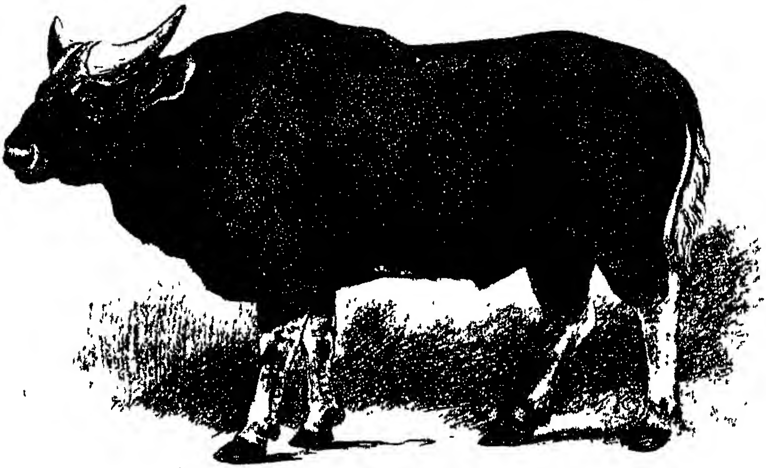

FIG. 166 —Gayal. *Bos frontalis.* × 1/20

The Banteng, *B. sondaicus,* is distributed through Chittagong, Tenasserim, and the Malay Peninsula to Java and Borneo. There are apparently two races of this animal. The species differs from the others by the fact that the horns are smaller and more curved; there is a white caudal disc; the forehead is narrower and the skull longer than in the others.

The American Bison and the European Aurochs form another section; they are indeed extremely alike, specific differences being hardly recognisable. The Bison of America, formerly present in such numbers that the prairies were black with countless herds, has now diminished to about a thousand head.

One of the largest of existing Bovidae is the Aurochs, Wisent, or European Bison, *Bos bonasus* (or *Bison europaeus*). It is exceedingly like its American relative. Formerly the animal was much more widely spread than it is now, extending its range from Europe into North America. It is now limited to certain districts on the Urals, in the Caucasus, and a herd of them are kept up through the fostering care of the Emperor of Russia in the forest of Bielovege in Lithuania. The term "Aurochs" should not really be applied to this species but to the Wild Cattle, *Bos taurus.* It is, however, so generally used for the Wisent (which is the German name) that it

[1] See *Proc. Zool. Soc.* 1890, p. 592.

is not necessary to change it. The Sclavonic name is Zubr or Suber. It is a great beast, standing 6 feet or so in height at the shoulder. It ranged further over Europe well within the historic period. In the days of Charlemagne it was spread over Germany and was a beast of the chase. In the year 1848 the Emperor of Russia presented a pair of these Oxen to the Zoological Society of London At the time of their presentation an interesting communication was made to the Society by M. Dolmatoff, on the method of the capture of these two examples. The creature is not easy to capture and is alarming to confront. "The eyes,"

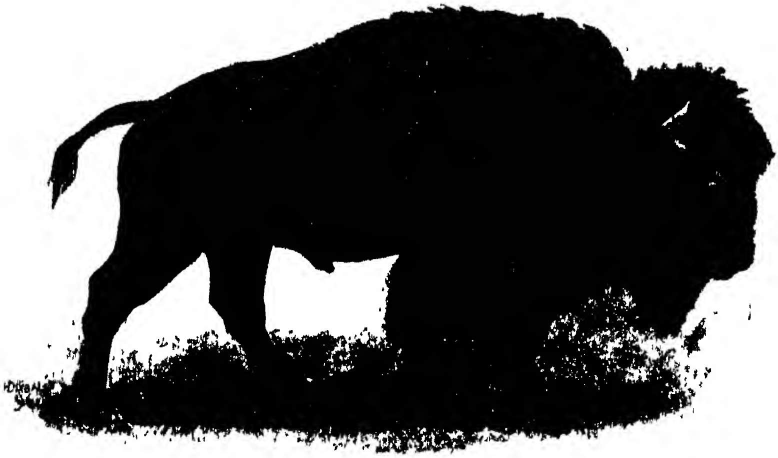

FIG. 167.—Bison. *Bison americanus.* × $\frac{1}{25}$.

says an old writer, "are red and fiery; the looks are furious and commanding." It has of course the shaggy mane and hump of the American animal. The herd in Lithuania was said to be 1900 in the year 1856. Mr. E. N. Buxton,[1] who has lately visited the forest, quotes M. Neverli to the effect that at present the numbers are not more than 700.

Allied to this animal, and apparently still nearer to the American Bison, is the extinct *B. priscus* of Europe. The Pleistocene Bisons of North America, *B. antiquus* and *B. latifrons*, are not remote from the living forms. Finally, the Miocene *B. sivalensis* from India, and the Pliocene *B. ferox* and *B. alleni* of North America, take back this group to as remote a period as any other genus of Oxen.

[1] *Proc. Zool. Soc.* 1899, p. 64.

The Yak, *Bos grunniens*, is a long-haired peculiar type, confined

FIG. 168.—Yak. *Bos grunniens.* × $\frac{1}{10}$.

to the Thibetan plateau. *B.* (*Anoa*) *depressicornis* of Celebes is characterised by its straight horns; allied to it is *B. mindorensis*

FIG. 169.—British Wild Ox. *Bos taurus.* From Vaynol Park, Bangor. × $\frac{1}{20}$.

(Philippine Islands), supposed, however, to be a hybrid between

it and some other species. Africa has at least two Buffaloes. We may finally mention the Wild Ox of Europe, *B. primigenius*, the supposed progenitor of our domestic cattle, believed to be still surviving in the herds at Chillingham, Chartley, and elsewhere. This animal is sometimes called the Aurochs. The Romans spoke of it as the Urus, and it appears to have formerly attained to more gigantic proportions than at present. It is the small size of the present race that is the chief objection to tracing them back to the large Oxen existing near London in 1174, and found sub-fossil in the Cambridgeshire fens.

Of the true sheep, genus *Ovis*, there are a considerable number

FIG. 170.—Punjab Wild Sheep. *Ovis vignei*. × $\frac{1}{16}$.

of species. The Sheep are to be distinguished from the Goats by their rather stouter build and by the absence of the beard in the male. The horns are developed in both sexes, and are usually twisted and often of large size.

The Sheep are almost entirely Palaearctic and Nearctic. They only just get into the Oriental region. One of the finest species is the great Pamir Sheep, *O. poli*, whose length reaches 6 feet

7 inches, and height 3 feet 10 inches. The horns of this fine Sheep may measure more than five feet round the curves. The Rocky Mountain Bighorn (*O. montana*) is a Sheep ranging along the Rockies as far south as New Mexico, and also to the far north; they are not confined to the chain of mountains mentioned, but occur also on the mountains of British Columbia down to those of California. The horns are not quite as large

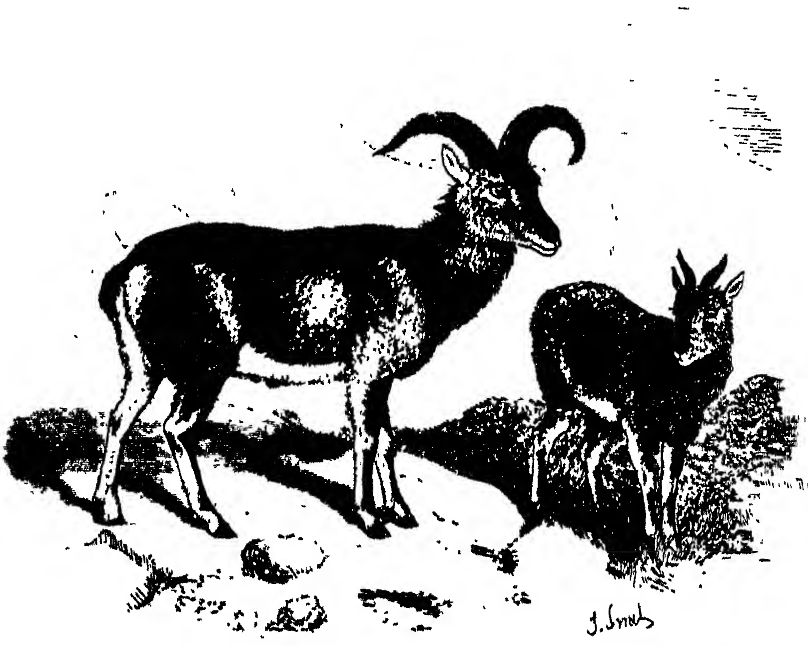

FIG. 171.—Himalayan Burrhel Sheep. *Ovis burrhel.* × 1/12. (From *Nature.*)

as those of the last species, but measurements give a length (along the curve) of 32 to 40 inches.

Just as the Goats are often limited to islands and small stretches of country, so are the Sheep. Thus Cyprus has a species, *O. ophion*, peculiar to itself. This, which is known as the Cyprus Moufion, is limited to a range of mountains, the Troodos, in that island. In 1878 it was believed that the animal was nearly exterminated, a flock of twenty-five members alone surviving. They have, however, since increased. Confined

FIG. 172.—Blanford's Sheep. *Ovis blanfordi.* × $\frac{1}{10}$. (From *Nature.*)

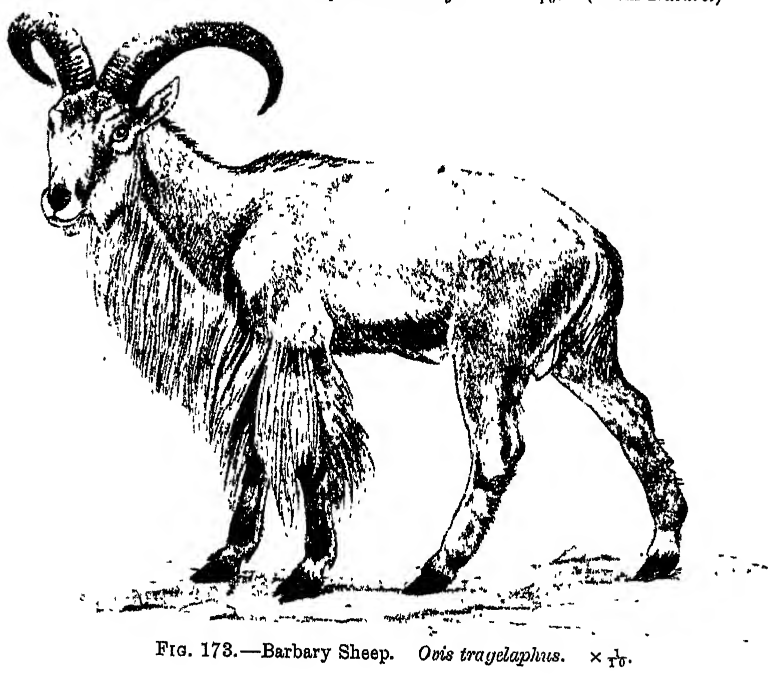

FIG. 173.—Barbary Sheep. *Ovis tragelaphus.* × $\frac{1}{10}$.

to the Thibetan plateau are *O. hodgsoni* and *O. nahura* Corsica has the Moufflon, *O. musimon*; and the Barbary Sheep or Aru, *O. tragelaphus*, is found only in Northern Africa. *Ovis burrhel* and *O. blanfordi* are Indian forms.

Ovis nahura is chiefly responsible for the impossibility of strictly separating the Sheep and Goats. It has no suborbital glands or lachrymal fossae, which are as a rule present in the

FIG. 174. Thar. *Capra jemlaica*. × 1/16. (From *Nature*.)

Sheep and absent from the Goats. On the other hand interdigital glands are present, which is the case with Sheep. Its habits, too, are a blending of those of the Sheep and the Goat. It lives largely on undulating ground like Sheep, and frequently lies down during the day on its feeding ground. On the other hand it is, like the Goats, a splendid climber.

The Goats, genus *Capra*, differ from the Sheep in their slighter build and in the fact that the horns are not spirally curved, but arched over the back. There is also the characteristic beard,

and the male is odorous. The true Goats are almost exclusively Palaearctic in range. They show the limited distribution of the Sheep, a distribution which follows from their mountain-loving habits.

Thus we have the Spanish Ibex (*C. pyrenaica*), limited to the Pyrenees and other mountain ranges of the peninsula;

FIG. 175.—Sinaitic Ibex. *Capra sinaitica* × $\frac{1}{15}$.

C. ibex, the Steinbok of the Alps and the Tyrol; the Markhoor, *C. falconeri*, of certain mountain ranges of Afghanistan; the Caucasian, Sinaitic, and Cretan Ibexes, and the Thar.

Capra aegagrus, the Persian Wild Goat, ranges from the Caucasus to Sind. It is this animal which produces the true "bezoar stone." The substance in question is a secretion apparently found in the stomach. It is still, according to Mr. Blanford, regarded as an antidote to poison in Persia. Buffon called this Goat the "Pasan," which is evidently a corruption of the word bezoar. When the substance was in repute as a medicine of the "alexipharmic" kind, the supply naturally came up to the demand. Thus the bezoar stones of the Lama in South America gained repute, and there were "Oriental bezoar, cow

bezoar, hog bezoar, and monkey bezoar"! As concretions of one kind or another are not uncommon objects in the alimentary tract of mammals it was easy enough to obtain a fair amount of some substance which was sure to sell well. It is said that a stone weighing four ounces was once sold in this country (or at any rate in Europe) for £200.

"There can be no doubt," observes Mr. Blanford, "that *C. aegagrus* is one of the species, and probably the principal, from which tame goats are derived."

The Chamois (*Rupricapra*) and the Goral (*Nemorrhaedus*) are

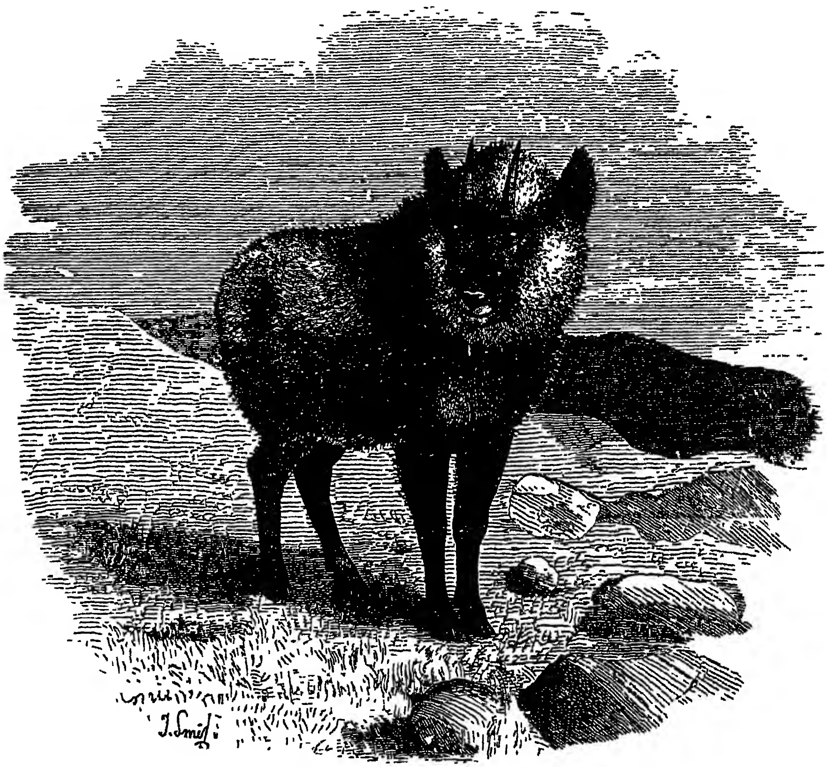

FIG. 176—Japanese Goat Antelope. *Nemorrhaedus crispus.* × $\frac{1}{12}$. (From *Nature.*)

best described as Goat-like Antelopes; but, as already said, it is difficult to split up the Bovidae satisfactorily. The Rocky Mountain Goat, *Haploceros montanus,* is a large Goat-like creature,

which has the peculiarity of having the shortest cannon bones of any Ruminant. Its name denotes its range

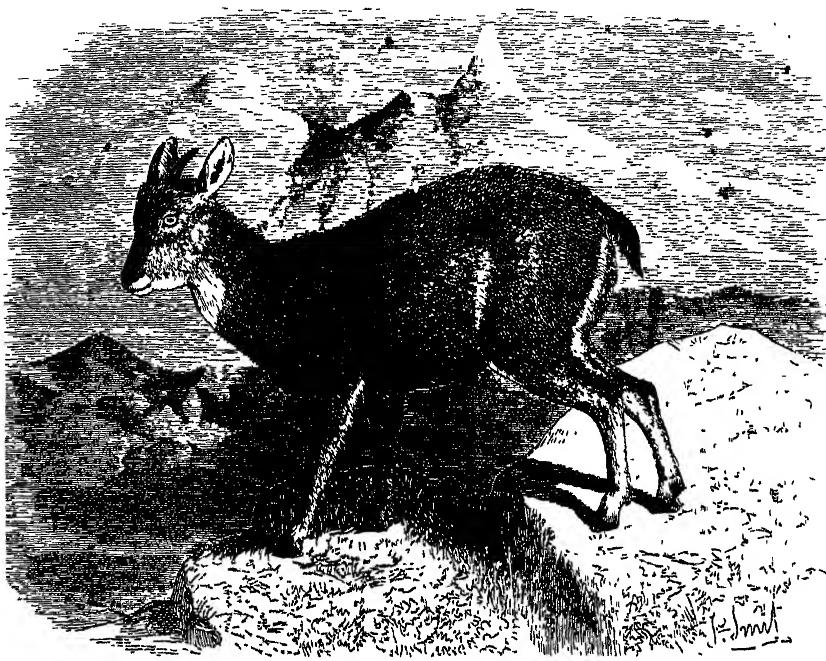

FIG 177 —Goral. *Nemorrhaedus goral.* × $\frac{1}{12}$. (From *Nature.*)

The Musk Ox, *Ovibos moschatus,* has been thought to be on the borderland between the Sheep and Oxen, as indeed expressed in its scientific name. It is a purely Arctic creature, now confined to the Nearctic region; but it formerly existed in the Arctic regions of Europe.

The anatomy of the "soft parts" of this genus has lately been investigated by Dr. Lonnberg[1] The animal has no foot glands such as occur in *Ovis.* Its kidneys, however, are non-lobate, and it has orbital glands. The cotyledons of the placenta are unusually large, and the cow has the "primary four" teats. It cannot, in fact, be definitely referred to either the Caprine or the Bovine section of the Cavicornia, and while possibly most allied to *Budorcas,* it may be regarded, at least for the present, as entitled to form a separate sub-family of its own. The muzzle

[1] *Proc. Zool. Soc.* 1900, p. 142.

has a slight naked strip above the nostrils, as in the Sheep, but there is no fissure of the upper lip.

Extinct Families of Artiodactyla.

The origin of the Artiodactyla is placed by Cope in the family **Pantolestidae,**[1] allied to the genus *Protogonodon* of the Condylarthra. As, however, this family is represented by but a few back teeth and a fragment of the hind-foot, it seems premature to regard it as the necessary starting-point of the Bunodont and Ruminant groups.

Fam. Anthracotheriidae. — This well-known and ancient family consists of creatures of for the most part a Pig-like form, with teeth approaching the selenodont shape, and a complete dentition. The carpals, tarsals, metacarpals, and metatarsals are all free. The toes are four (or five) to each foot, with the outermost beginning to be reduced. These of course are all generalised and primitive characters, pointing nowhere in particular, except, of course, to an Artiodactyle stock, on account of the teeth and the two predominating toes.

The type genus of the family, *Anthracotherium*, is not, as its name might seem to denote, a relic of the Carboniferous period; its remains were found in lignite, which may also show that it was at least semi-aquatic in habit. Its form, however, must have been Pig-like, so at least one would presume from the elongated skull and shortish legs. There were species as great as a Rhinoceros, and smaller forms. The genus began in the Oligocene and continued down to the Pliocene. It is known from Europe, Asia, and America.

The skull is long with a prominent sagittal crest. The facial part is also very long, and the orbits are not closed by a bony ring. The premolars are simple teeth; the molars distinctly bunodont with a tendency in one or two to the selenodont condition. The canines are powerful, as are also the incisors. The scapula has been specially compared with that of the Camel. It has no acromion, which is usually though not always absent in Ungulates. An ally of the present animal, for instance, the Hippopotamus, has the acromion developed The radius and ulna, the tibia and fibula, are all fully developed.

[1] The name *Trigonolestes* has to be substituted for *Pantolestes*.

Ancodus (or *Hyopotamus*, as it has been called) is also Oligocene in range, and its remains have been found in the same countries as have those of *Anthracotherium*. Both genera are indeed closely allied. *Ancodus* seems to be a more slightly-built creature. The skull looks weaker, but presents much the same features of organisation. In *A. velaunus*, a species found in French rocks, a metacarpal of digit I. was present in the manus, while *A. brachyrhynchus* had a completely five-fingered manus.

The Miocene genus *Merycopotamus* (from the lower layers of the Siwalik formation in India) is more distinctly selenodont than the forms already discussed. On this ground it has been placed in a separate sub-family. As, however, in other respects it does not depart from the Anthracotherian type of structure, this proceeding seems to be hardly necessary. There are two species known, of which one, *M. nanus*, is, as its name denotes, a dwarf form.

Fam. Caenotheriidae.—While the last family consisted of animals rather more akin to the Pigs, the present is more Pecorine in its characters. The molars are selenodont; but as in the Tragulidae the premolars are more of the nature of cutting teeth. The dentition, like that of so many of these early Ungulates, is complete, and the canines are not prominent. The feet are four-toed, the lateral toes not reaching the ground.

The principal genus is the Eocene and Miocene *Caenotherium*. Of this genus there were a considerable number of species all European in range, and of small size—not more than a foot or so in length. Their small size is suggestive of the Chevrotains. In the skull the orbital cavity is nearly or quite surrounded by bone, and the tympanic bulla is large and inflated. A common feature of Artiodactyles, a failure of the nasals and maxillae to meet at the side of the face, is to be seen in this ancient forerunner of the Pecora.

Plesiomeryx, also European, and from the same geological horizon, is a very closely allied form.

Fam. Xiphodontidae.—This family consists of slender, small Artiodactyles which are, like the Caenotheriidae, related to the Pecora. They are confined in their range to Europe.

The type genus *Xiphodon* has selenodont molars and elongated, slender, cutting premolars. The dentition was complete and the canines not highly developed. Like *Caenotherium*,

Xiphodon was a hornless creature, but with only two toes, the two lateral digits being represented by the merest rudiments of metacarpals. The other metacarpals were unusually long.

Amphimeryx (also called *Xiphodontotherium*) is much more imperfectly known, but belongs to this family or to that of the Caenotheridae. *Dichodon* is another member of the same family.

Fam. Oreodontidae.—This family, consisting of numerous genera, is limited to the North American continent. Its range in time is from the Eocene to the Lower Pliocene. The family as a whole is to be distinguished by a number of primitive characters. The dentition is complete; the feet are four- or even five-toed; the orbit is sometimes open behind. The canines of the lower jaw are not more pronounced than the incisors. The characteristics of the group will be further developed by a consideration of some of the principal genera which are included in this family.

Oreodon is a Miocene form about as large as a Peccary. The skull has a short face with a completely-closed orbital cavity. In front of the orbit is a deep pit, not a mere deficiency of ossification, such as occurs in many Artiodactyles This is placed on the lachrymal bone, and is in fact a lachrymal fossa, such as occurs in other forms. The odontoid process of the axis vertebra is somewhat cheese-taster shaped, as in recent Artiodactyles. There are fourteen dorsal vertebrae and a very large number of caudals. The radius and the ulna are completely separated, as are the carpals. There are five digits to the fore-limbs. The fibula is complete and independent. The hind-foot is four-toed. Several species of the genus are known.

Merycochoerus is an allied Miocene genus. It is more massive in form than the last, but otherwise does not present differences of importance.

Mesoreodon is another genus of this family which presents some curious features of organisation. In the skull and teeth there is nothing very noteworthy, but the hyoid is remarkable. This appendage of the skull is by no means always preserved, and when it is, it might be denied that it belonged to any particular skull. In the present case there appears to be no doubt as to the identity of the bones, which resemble the corresponding bones of the Perissodactyla much more than they do those of other Artiodactyles. Associated with the bones an ossified

thyroid cartilage of the larynx was found. As the skull was that of a male, this character may be a sexual one. It is quite comparable to the ossification of the same cartilage in the American monkey *Callithrix*. "The function of the bone," observes Professor Scott,[1] "was probably similar to that performed by the enormously-inflated basihyal of the howling monkeys, and must have given to these animals most unusual powers of voice." Another important anatomical fact about *Mesoreodon* is the apparent existence of a clavicle. It is of course conceivable that the remains of some other animal have got mixed up with that of the individuals upon which the present genus is founded; but failing that, here is a clavicle in an Ungulate. The spine of the scapula possesses a metacromion. This greater development of the spine of the scapula in Artiodactyles than in Perissodactyles is, it is suggested, to be correlated with the earlier loss of the clavicle in the latter group of Ungulates.

Cyclopidius (synonymous with *Brachymeryx*) is a kind of pug form of *Oreodon*. The skull is short and broad, and the end of the snout a little turned up. The upper incisors are small and drop out early. On each side of the nasals is a large oval vacuity which is perhaps to be compared to the lateral deficiency to be found in other Artiodactyles. One species of this singular-looking form is appropriately called *C. simus*.

Other allied genera are *Merychyus* and *Leptauchenia*. The former extends as far down as the Lower Pliocene, and is thus one of the newest forms of Oreodontidae.

Agriochoerus[2] (Fig. 178) is placed in a separate sub-family from the types which have just been considered. It is Miocene in range. It differs from *Oreodon* and its closer relatives by the fact that the orbit is open behind and not closed. The most remarkable fact about this creature is that the terminal phalanges of the digits (five in the fore- and four in the hind-feet) being pointed, seem to suggest their encasement with claws rather than hoofs. The pollex, though small, seems to have been opposable. As with other Oreodonts, the molars are selenodont. The premaxillae are toothless—at least in adults, for two teeth are present in the

[1] *Trans. American Phil. Soc.* xviii. 1896, p. 125.

[2] For complete osteology see Wortman, *Bull. Amer. Mus. Nat. Hist.* vii. 1895, p 145.

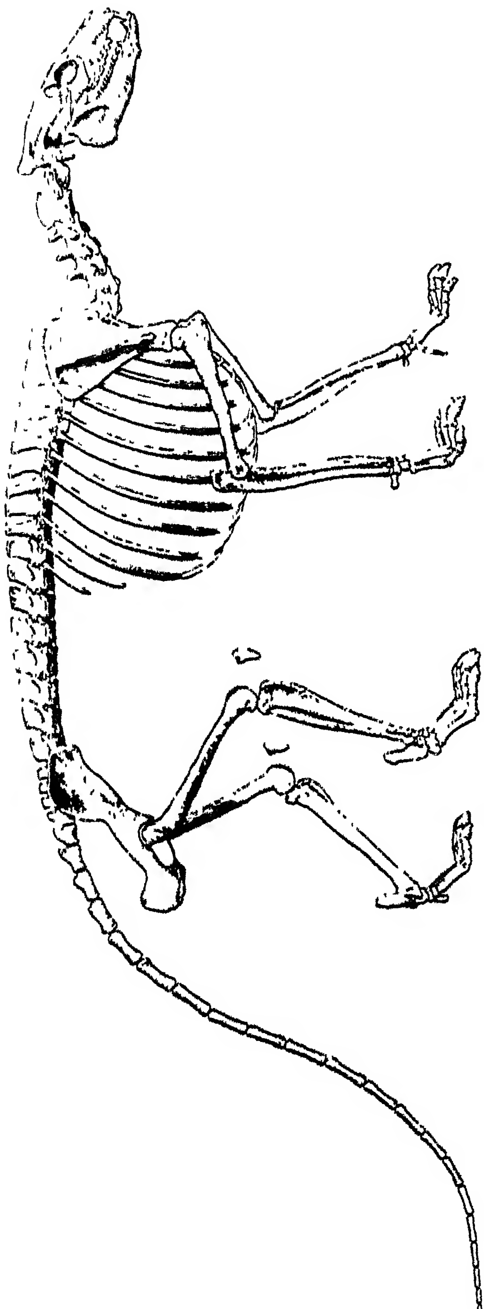

Fig. 17[illegible].—Skeleton of *Agriochoerus latifrons*. [illegible] (After Wortman.)

young. There are several species *Agriochoerus*, like *Oreodon* and primitive Ungulates in general, had a long tail. The genus thus shows a mixture of ancient and specialised characters.

The most ancient form of Oreodont is *Protoreodon*. This is Eocene, and became extinct during that period. It had a complete dentition, open orbit, and no lachrymal fossa. The fore-feet were five-toed, the hind four-toed

Fam. Anoplotheriidae. — This family is entirely Eocene in point of time, and is unknown outside Europe. The dentition of the group is complete; the molars are selenobunodont, like those of the Anthracotheriidae. The bones of the carpus, tarsus, metacarpus and metatarsus are all free; the toes are four to two in number on each foot. The orbit is widely open behind. The tail is long, as in *Xiphodon*, etc.

These general characters only just serve to differentiate the family; but they illustrate its archaic character, in which it resembles the Xiphodontidae, and even more the Anthracotheriidae. A survey of some of the genera which have been assigned to the family will bring out other features in the organisation of these very ancient Artiodactyles.

Anoplotherium is so called on account of the fact that it is, like all ancient Artiodactyles, without horns or claws. Tusks it might have, but as a matter of fact has not. There are, as in Artiodactyles generally, nineteen dorso-lumbar vertebrae; the long tail has numerous chevrons. The shoulder blade has a well-marked acromion and a distinct coracoid process; it is wide proximally. The bones of the fore-arm and fore-leg are, as is usual in primitive Artiodactyles, separate.

In the skull the chief features, in addition to that mentioned in the definition of the family, are the large size of the par-occipital processes; there is no fossa lachrymalis or deficiency in the side of the face. The animal is three-toed, both in the fore- and hind-limbs. The second toe is nearly as large as the Artiodactyle third and fourth. There are tiny rudiments of the two remaining fingers. The hind-foot is also three-toed, and there is a trace of the hallux The fingers are so widely separated and divergent from each other that it has been suggested that the animal had webbed feet and inhabited marshes, in which it swam by the aid of its long tail. The creature was the size of a Tapir.

Closely resembling *Anoplotherium* are a number of other genera.

Diplobune (= *Hyracodontotherium*) was much like the last, but was a more delicately-formed animal The fingers and toes (three of each) end in such sharply-pointed phalanges that claws seem to be almost suggested. There are several species of this genus. *Dacrytherium* differs by the presence of a lachrymal fossa.

Dichobune has four-toed extremities, of which the lateral ones are more slender and shorter than the two middle ones. As in other Anoplotheriidae, the anterior premolars are furnished with a sharp cutting edge.

Order V. SIRENIA.

Aquatic Mammalia, with but few scattered hairs; hind-limbs absent; fore-limbs paddle-shaped; tail flattened, and either Whale-

like or rhomboidal to circular in form. Nostrils on upper surface of not specially-elongated snout. Clavicles are absent. The scapula has the normal mammalian form, with a well-developed and roughly median spine. The bones of the arm and hand articulate together, as in land animals; the phalanges show at most traces of increase in number above the normal. Pelvis represented by a vestige, more highly developed in some fossil than in recent forms. Stomach complex, consisting of several chambers. Lungs simple and not lobulated. Diaphragm oblique and very muscular. Brain peculiar in form and but slightly convoluted. Testes abdominal. Teats two, and pectoral in position. Placenta non-deciduous and zonary.[1]

This limited group consists of purely aquatic forms, which are both marine and fresh-water in their proclivities. They have been placed in the immediate vicinity of the Whales; but it is now believed by most zoologists that the likenesses which they undoubtedly show to the Cetacea are of an adaptive kind and related to their similar mode of life. The group is a readily-definable one. Externally they are marked by their dark coloration, somewhat Whale-like though of clumsier build, and by the total absence of external ears and hind-limbs; the latter are, however, as will be pointed out shortly, marked by certain rudimentary bones. There is a flattened tail, which in the Dugong and *Rhytina* is precisely like that of a Whale. It is interesting to note that the former genus, whose tail is, judging it at least by the standard of the Whales, more completely modified for the aquatic life, should also show other features which indicate their longer life as marine creatures. For the flippers are more Whale-like in that the fore-arm is completely enclosed within the body, or nearly so, and the nostrils have a more decidedly superior position than in the Manatee. The fore-limbs of this group, as may be inferred from what has just been said, are flipper-like; but, contrary to what we find in Whales, the phalanges do not as a rule show any traces of multiplication, so characteristic a feature of the Cetacean hand, and the individual bones are connected by well-formed joints. Beneath the thick skin, which is sparsely provided with stout hairs in the Dugong, is a layer of blubber. Dr. Murie has called attention to the fact that this layer in the

[1] In *Halicore;* probably also in *Manatus*. See Turner, *Trans. Roy. Soc. Edinb.* xxxv. 1889, p. 641.

Manatee[1] differs from the blubber of the Whale in that there is no free oil anywhere.[2]

The skeleton of the Sirenia is strong and massive, thus contrasting with the loosely-textured bones of the Cetacea. The cervical vertebrae are, as a rule, free, but the second and third are fused in *Manatus* and the extinct *Halitherium*. It is noteworthy that in *Rhytina* the cervical vertebrae have the exceedingly thin centra that characterises the neck vertebrae in Whales. The ribs are most of them firmly articulated by two heads. The breastbone is generally reduced, as in Whales; and but few ribs are attached thereto. The vertebrae, moreover, are well locked together by zygapophyses, and not loosely attached as in Whales.

The shoulder blade is long and narrow, and not unlike that of the Seals. It is totally unlike the peculiarly-modified scapula of the Whale tribe. But, as in the latter, there are no clavicles.

The hind-limbs are only represented by the pelvis; and this is a rudimentary structure, varying, however, in the degree of its degeneration. That of the extinct *Halitherium* recalls the pelvis of the Rorqual. There is a single triradiate bone, with an acetabular cavity for the rudiment of the femur in the centre; it suggests that here the three normal elements of the pelvis have become fused into a single bone. In the Dugong there are two small bones on each side.

The Manatees (*Manatus*)[3] are found in the fresh-waters and along the Atlantic coasts of South America and Africa. It appears that there are four species, of which one only is African, the others American. Report asserts the former occurrence of this genus on the shores of St. Helena.

The Manatee is provided with only six cervical vertebrae, a fact which distinguishes it from the other existing genera of its group. A remarkable feature which it exhibits is the large number of molar teeth. These apparently go on increasing indefinitely during its life, the suggestion being that they are worn away by the nature of the food—algae with much sand intermixed. As many as twenty molar teeth have been counted in one half of the jaw, and there is no reason to forbid the assumption that they

[1] Kukenthal has discovered a thick coating of rudimentary hairs in the foetus of the Manatee, thus showing that it is the descendant of an animal furry like a Seal.

[2] "On the Manatee," in *Trans. Zool. Soc.* vol viii 1872, p. 127.

[3] Hartlaub, "Beitrage zur Kenntnis der Manatus-Arten," *Zool. Jahrb.* 1886, p 1.

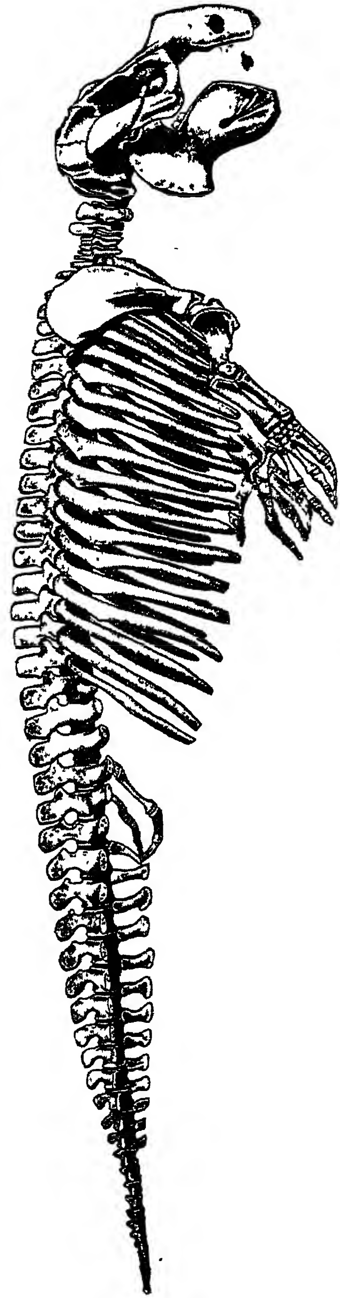

FIG. 179.—Skeleton of Dugong *Halicore australis*. (After de Blainville.)

may get still more numerous. This large number of grinding teeth is obviously suggestive of the Whales, with which the Sirenia are believed by some to be allied. It is at least a remarkable coincidence that these two aquatic groups of mammals should both have assumed the same indefinite tooth formula. It is correct to say assumed, since extinct forms of Manatees, such as *Halitherium* and *Prorastoma*, have not a continuous succession of molars. The brain of the Manatee is, contrary to the usual arrangement among aquatic mammals, smooth, and only marked by one or two fissures.

The Manatee[1] is black in colour, its thick skin being wrinkled. The animal is assisted in feeding by a curious mechanism of the upper lip; this is split in two, and the two halves, which are furnished with strong bristles, can play upon each other like the points of a pair of forceps. The flippers are furnished with nails, save in *M. inunguis*, but in the nailed forms it is not every finger which is thus armed.

Halicore,[2] the Dugong, is an entirely Oriental and Australian

[1] Beddard, "Notes upon the Anatomy of a Manatee (*Manatus inunguis*)," *Proc. Zool Soc.* 1897, p. 47.

[2] See Kukenthal in Semon's "Zoolog. Forschungen," *Denkschr. Jen.* 1897; Langkavel, "Der Dugong," *Zool. Garten*, 1896, p. 337.

form, there appears to be but a single species, though more than one name has been given to supposed distinct species. As already mentioned, it differs from the Manatee in the possession of a Whale-like tail; the nostrils, too, are more upon the upper surface of the head, and there are no nails upon the flipper. The peculiar cleft lip of the Manatee is not so well developed in the Dugong, but there are traces of it; and in the foetus the likeness to the Manatee in this respect is very striking. It would thus appear that *Halicore* is a stage in advance upon *Manatus*; that the remarkable mechanism of the lip of the latter has been possessed, but has been lost, by the Dugong. The skull of the Dugong is distinguished by the stout premaxillary bones, which bear a tusk in the male. In the female the tooth is there, but is lodged within the bone. This incisor has a milk forerunner. The back teeth of the Dugong (there are no canines) are few in number (four or five, even six), thus showing a gradual reduction when compared with *Manatus*; and this culminates in the toothless *Rhytina*. It is also interesting to notice that in the massive lower jaw there are traces of an incisor. Were this to be developed into a tusk, the jaw would present a curious resemblance to that of *Dinotherium*.

The Dugong, *H. dugong*, has the reputation of being the original of the mermaid legends, since the young is held to the pectorally-situated breast with one flipper. "But it should be remembered," justly observes Dr. Blanford, "that stories of beings half man or woman, half fish, are as common in temperate as in tropical seas, and that some of them are more ancient than any European knowledge of the Dugong."

Extinct Sirenians.—The earliest genus that can be with certainty referred to this order is the Oligocene *Prorastoma*. This genus, though offering no particular skull-characters that assist in the determination of the much-debated affinities of the Sirenia, shows a remarkable condition of the teeth that may afford a clue. The species *P. veronense*, recently described by Mr. Lydekker,[1] is founded upon a fragment of the skull which contains two teeth apparently representing the third and fourth upper milk molars. The interest attaching to these teeth lies in the fact that they clearly exhibit the buno-selenodont condition characteristic of certain early Artiodactyles, e.g. *Merycopotamus*.

Halitherium is a later genus, which is known by the nearly

[1] *Proc. Zool. Soc.* 1892, p. 77.

complete skeleton. The skull is like that of other Sirenia, with the down-turned premaxillary region. But the nasal bones, lost, or at least rudimentary, in recent forms, are well developed; the likeness of ancient to living forms in this respect being exactly paralleled by the Zeuglodonts, when compared with recent Whales. The vertebral centra exhibit distinct epiphyses, which have disappeared in living Sirenians. The cervical vertebrae are seven, of which the second and third are occasionally fused. There are nineteen pairs of ribs, and there are three lumbar vertebrae. The sternum consists of three separate pieces. There is a rudimentary femur.

The recently-extinct Steller's Sea-cow, belonging to the genus *Rhytina*, was a huge beast, seen in the flesh up to nearly the end of the last century. It frequented the shores of Bering's Straits. Its remains occur in the peat on the shores of those seas. It reaches a length of some 20 to 30 feet. The external characters were much like those of other recent Sirenians. The nostrils were above the fore part of the snout, the latter being truncated and obtuse. The tail was of the Cetacean pattern, and thus like that of *Halicore*. The head of this Sirenian was small, and the teeth had entirely vanished save for the apparent existence as transitory structures of two small incisors in the upper jaw. The absence of teeth was compensated by the presence of a horny palate for the trituration of the sea-weeds which constituted the food of Steller's Sea-cow. The fore-limbs seem to have possessed no nails, but were covered at the extremity with short, bristly hairs, no doubt serving the purpose of keeping the animal moored in safety to the slippery beds of Fucus upon which it browsed.

There are nineteen pairs of ribs. The vertebrae of the cervical region are the customary seven, and the centra are thin and plate-like as in the Cetacea, the animal being thus short-necked like those marine creatures.

CHAPTER XII

CETACEA—WHALES AND DOLPHINS

Order VI. CETACEA.[1]

AQUATIC Mammalia of fish-like form; tail expanded into horizontal flukes, a fatty dorsal "fin" present in most species; anterior limbs converted into fin-like paddles; posterior limbs only represented by skeletal rudiments. Hairy covering reduced to a few isolated hairs in the neighbourhood of the muzzle. Nostrils represented by the single or double blow-hole, nearly always situated far back upon the skull. Bones of loose texture and much impregnated with oil. The skull has a greatly-developed facial portion; supra-occipital bones meeting the frontal by overgrowing, or growing in between the parietals; bones surrounding the organ of hearing loosely attached to the skull, the tympanics of peculiar cowrie-shell form. Coronoid process of mandible absent, or very feebly developed. Teeth, when present, few or numerous, always of simple conical form, with at most traces of additional cusps (*Inia*); if absent their place taken by whalebone. Cervical vertebrae of short antero-posterior diameter, often more or less completely welded together into a single mass. Articulations between dorsal and other vertebrae feeble. Scapula peculiarly flattened; acromion strongly developed as a rule, but arising from a slightly-marked spine; coracoid process generally strongly developed. Phalanges of digits always more numerous than in other mammals. Clavicles absent. Stomach complex, consisting of at least four and often more chambers. Lungs simple and non-lobulated. Diaphragm obliquely set and very

[1] See van Beneden and Gervais, *Ostéographie des Cétacés;* and for a more general account Beddard, *A Book of Whales*, London, Murray, 1900.

muscular. Brain much expanded transversely and well convoluted. Testes abdominal. Teats two, inguinal in position. Placenta diffuse and non-deciduate.

The Whales and Dolphins, which constitute this order, form an assemblage which is easily characterised by reason of the fact that their affinities to other groups of Mammalia are so doubtful that they furnish matter rather for speculation than for authoritative statement. Some hold that they resemble in certain points the Ungulata; while others again see in them the culminating term of a series which commences with such a form as the Otter, and of which the Seals and Sea-lions are intermediate stages. A third opinion is that the Whales have arisen from some low mammalian stock, too primitive to be assigned to any existing order of mammals. Palaeontology, as will be seen later, throws no light whatever upon their origin. This matter has already been referred to (see p. 120) in considering the position of the Cetacea

The Whales include the most gigantic of all the orders of vertebrated animals. No creature living or extinct is so large as the Sibbald's Rorqual, which attains to a length of some 85 feet, or perhaps even rather more. On the other hand we have what are by comparison minute forms. Apart from the possibly problematical *Delphinus minutus*, stated to be only 2 feet in length, we have as a minimum 3 or 4 feet. The size of the Cetacea has been subjected to much exaggeration. The first duty of a Whale, observed the late Sir William Flower, is to be large; and Natural Historians, in the recent as well as in the remote past, have not hesitated to put very round numbers upon the dimensions of the larger members of the order. We may perhaps pass over Pliny's "fish called balaena or whirlpool, which is so long and broad as to take up more in length and breadth than two acres of ground," and a number of analogous exaggerations, which gradually dwindled down to the dimensions just stated of the great Rorqual. M. Pouchet has made the ingenious suggestion that the statements of the ancients may have been nearer the truth than observations of to-day would have us believe; he pointed out justly that in former times Whales were not so relentlessly pursued as during the last century; the inference being that they may have lived to a greater age, and attained a more colossal bulk. The more modern exaggerations in the

dimensions of the bigger Whales are probably due to the fact that measurements have been taken, not in a straight line from snout to tail, but along the bulging sides of the Cetacean, rendered even more convex than in nature by decomposition, and by pressure due to the immense tonnage of the creature.

The Cetacea are the most perfectly aquatic of all mammals; they never leave the waters which they inhabit. It is true that legends have represented them as pasturing upon the shore—Aelian spoke of Dolphins basking in the sun's rays upon the sand; and the "Devil Fish" of California, *Rhachianectes* (see p. 357) has given rise to improbable stories—but they are

Fig. 180.—Killer *Orca gladiator*. $\times \frac{1}{40}$ (After True.)

apparently only legends. Indeed a stranded Whale cannot live long, for it is unable to breathe, the comparatively feeble breast being crushed by its own weight. In accordance with the purely aquatic habit, we find a modification of the outward form of the body (and as we shall see later of many of the internal organs), which renders the Cetacea externally unlike all other mammals. The form is fish-like, the fore-limbs are paddles, the tail is expanded into two horizontal flukes, which serve to propel the creature through the water.

The skin is smooth and shiny, so smooth and so shiny that it has often been compared to coach leather. But nevertheless they are not entirely without that most essential character of the class Mammalia, a coating of hair. The hairy covering is, however, reduced to the very smallest proportions; it is represented

by a few hairs only—so few that they can be counted with ease—in the neighbourhood of the muzzle. These hairs are not present in all Whales; they are absent, for example, in the White Whale or Beluga. When present they are not furnished either with sebaceous glands or with muscular fibres, which are such universal concomitants of the hair follicles in the Mammalia generally. This appears to be conclusive evidence that the hairs, few as they are, are still undergoing degeneration. The need for a furry coat is removed by the presence of a thick coating of fat immediately underlying the skin. This is known as the blubber, and is the main incentive to the pursuit of Whales. It must not, however, be assumed without further argument that the hair is absent because its place is taken, as a mechanism for retaining the heat, by the blubber; for the Seal tribe possess both fur and blubber. Another conceivable explanation is quite at variance with such a view of economy. It may be noticed that among Ungulates there is a tendency to lose hair, particularly among more or less aquatic forms. Thus the Hippopotamus is almost naked (as is indeed the Walrus); the Rhinoceros, too, often a frequenter of marshy soil, is almost as denuded as is the Hippopotamus. It is not, however, settled that the Whales have anything to do with the Ungulata, otherwise an additional argument might be used, that is, the secular loss of hair in some members of this group. The Hairy Rhinoceros, *Rh. tichorhinus*, was, as its name denotes, a hairy beast; the Mammoth was equally so. The descendants, or at least the modern representatives of both these creatures, are but scantily clad with hairs.

A final reason for the naked character of the skin in existing Cetacea is closely connected with a feature in the organisation of three or four living species which must first be described.

Some years ago the late Dr. J. E. Gray of the British Museum described from the sea, off Margate, what he considered to be a new species of Porpoise, characterised by the presence on the dorsal fin of a row of stony tubercles. As a matter of fact it was subsequently shown that the Common Porpoise has the same structures, so that there was no need for a Margate species, *Phocaena tuberculifera*. Moreover, in the Indian *Neomeris*, a close ally of the Porpoise, a more abundant calcified covering of scales exists along the whole back of the animal. These plates,

it has been discovered, are larger in the foetus, a fact which naturally points to their being an inheritance from the past, now undergoing retrogressive changes. Such a way of looking upon the facts is confirmed by the finding, many years ago, by the naturalist and physiologist Johannes Muller, of bony plates in connexion with the remains of a Zeuglodont Cetacean. It looks, therefore, very much as if the Eocene ancestors of the modern Cetacea had a skin studded with bony plates, as have the armadillos. This being the case, the disappearance of hair is not surprising. The room would be taken up by the calcified plates, and when the latter disappeared, as they have in the vast majority of existing Whales, the naked skin alone would be left.

Whales possess no externally-visible hind-limbs; rudiments of these appendages are present, which will be dealt with under the description of the principal features of the skeleton. But it has been discovered that in the Porpoise, external vestiges of hind-limbs do appear in the foetus, a fact which, be it observed, does away with the old view that the flukes of the Whale are the last term in the series of vanishing hind-limbs, of which the Seals, with their hind-limbs and tail bound up together, offer an intermediate step.

The tail is fish-like in form, but the flukes are horizontal instead of vertical as in fishes and *Ichthyosaurus*. This arrangement is no doubt associated with the need for rapid return to the surface waters after a prolonged immersion in search of food. A downward stroke, such as is given by the powerful and large tail flukes, would naturally bring about this result rapidly. The tail, moreover, is under all circumstances the swimming organ. Its motion has been stated to be slightly rotatory, like that of a screw, and it is the case that the two flukes are often alternate in shape like the flanges of a screw; one being convex upwards, the other convex downwards.

The fore-limbs are in the form of paddles, but they do not apparently serve as organs of locomotion so much as balancers. When a Whale is killed, it falls over on to one side, the office of the flippers being to maintain the proper position. It is believed, however, from the fact that the embryo often shows a relatively larger pectoral fin than that of the adult—the difference being due to a reduction in the adult of the number of phalanges—that the fin was once an organ of progression.

The pectoral fin of Whales exists in two forms. In the Toothed Whales it is shorter and rounder; in the Whalebone Whales longer and narrower. Structural differences accompany these outward dissimilarities. In the first-named group the humerus and the beginning of the radius and ulna are within the body, and do not form a part of the fin. In the Whalebone Whales, on the other hand, the fin contains all the bones of the fore-limb. Another remarkable contrast between the hand in the two groups of Whales is that while the Toothed Whales have five fingers, thus justifying the prevailing opinion that they are the more primitive of the two groups, the Whalebone Whales have only four fingers. Actually the Right Whale, *Balaena*, seems to have five fingers; and, indeed, the fact that it has, is often used to distinguish it from the Humpback, which has undoubtedly only four. But a careful consideration of the state of affairs which prevails in the foetus of *Balaenoptera* dispels this idea. Between what are apparently the second and third fingers, a rudimentary finger, consisting of four phalanges, appears. This is not produced, as is an additional finger found in the White Whale or Beluga, by a splitting of a finger. Accordingly the four-fingered condition of the Whalebone Whales is produced by the dropping out of a finger in the middle of the series,—a very remarkable fact. When fingers disappear, as, for intsance, in the Horse, etc., it is at the two ends of the series that the digits vanish. If this view of Professor Kükenthal's[1] be accepted, it follows that the presumed thumb of the Right Whale is what has been termed the prepollex.

The hand of the Whales, like those of some other aquatic creatures, *e.g.* the reptile *Ichthyosaurus*, has a larger number of phalanges than have terrestrial animals. The result of this is, of course, to increase the length of the fin and its utility as a paddle. It is commonly not all the fingers that have developed this great number of accessory phalanges. Rudimentary nails have been found upon the Cetacean hand; but in no case are they functionally developed. In the Manatees we have the disappearance of the nails still imperfectly accomplished. In *M. latirostris* there are nails; these have vanished, apart from possible traces to be seen with a microscope, in *M. inunguis*.

A very characteristic feature of certain Whales are the furrows

[1] *Vergleichend-anatomische Untersuchungen an Walthiere*, Jena, 1889-93.

to be seen on the throat. This is especially the case with the Rorquals, in which group the Humpback Whale, *Megaptera*, is to be included. The whales of these two genera (*Balaenoptera* and *Megaptera*) have a large number of the throat furrows—as many as sixty have been counted. Some other Whales have a smaller number; thus *Rhachianectes* has but two on each side, and the Physeteridae have not many more. These furrows are absent in very young embryos. It is thought by Professor Kukenthal that they allow of a wide opening of the mouth.

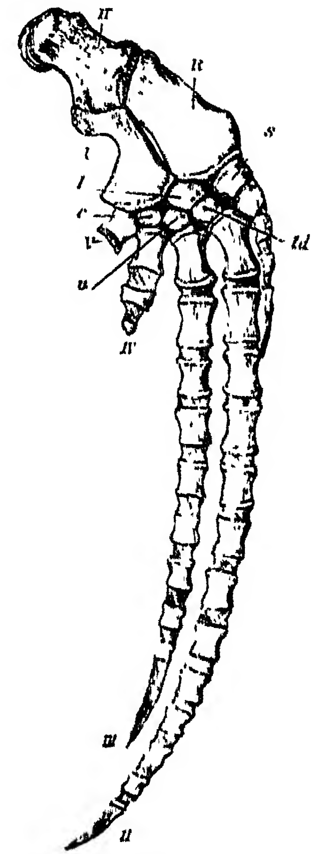

Fig. 181. Dorsal surface of bones of right anterior limb of Round headed Dolphin (*Globicephalus melas*). × $\frac{1}{6}$. The shaded portions of the digits are cartilaginous. *c*, Cuneiform; *H*, humerus; *l*, lunar; *R*, radius; *s*, scaphoid; *td*, trapezoid or magnum; *U*, ulna; *u*, unciform; *II-V*, digits. (From Flower's *Osteology*.)

The blow-hole of Whales is, of course, the aperture of the nostrils, which are not so far back in the foetus as in the adult. By the characters of the nostrils the Toothed Whales can be distinguished from the Baleen Whales; in the latter the orifice is double, in the former single. In embryos of Dolphins, however, the two apertures are quite independent. The phenomena of spouting have often been misinterpreted.[1] When the Whale breathes, the expired air rushes out through the nostrils. The water vapour in the breath condenses into drops of water in the cold Arctic regions where the phenomenon has been mainly observed. Hence the idea that water taken in at the mouth is expelled through the blow-hole. As the Whale approaches the surface to breathe, it may be that some of the water of the sea is

[1] "And at his gills draws in, and at his trunk spouts out, a sea," wrote Milton, and think many others

driven upwards by the forcible expulsion of air from the lungs. But for the most part the water which is spouted is simply condensed breath.

Like some, but not all, other aquatic Mammalia the Whales have apparently no external ear. Indeed the opening of the ear is excessively small. In a huge Rorqual it will "admit a quill", and although "a quill" is rather vague, we may fairly allow any sized quill without proving that the orifice of the auditory passage is anything but exceedingly minute. As a proof, added to so many, that the Whales are the progeny of terrestrial creatures, we have the occasional traces of external ears.[1]

FIG. 182.—Left lower jaw of foetus of *Balaenoptera rostrata*. Inner aspect, natural size, showing teeth. (After Julin.)

Whalebone Whales never possess permanent teeth as well as the baleen; but in the foetus are more than traces of true teeth, which, however, never arrive at maturity. The whalebone itself is described later (p. 354). That the Whalebone Whales possess teeth while in the foetal condition was discovered so long ago as 1807. It has since been confirmed by many observers. Not only is there one set of teeth developed in the foetal *Balaenoptera* but two, of which one comes to a greater maturity; the other, in fact, remaining at a very early stage of development. The more complete dentition belongs to the milk series, as is the case with the Toothed Whales. A very interesting conclusion with regard to the derivation of the simple conical teeth of Whales seems to follow from the development of these structures in *Balaenoptera*. There are in the young foetus fewer teeth than in the more advanced embryo. Now in the younger embryo some of the teeth are furnished with more than one cusp; they are bi- or even tri-conodont. As Sir R. Owen observed, the teeth—some of

[1] These have been recorded by Professor Howes in the Porpoise.

them—are literally double teeth. This is a suggestion of the more complicated teeth of the Zeuglodonts, and shows so far that the simple conical teeth of existing Whales (cf. however the Platanistidae) are not by any manner of means so primitive as their actual structure would undoubtedly lead one to believe. Further than this, the greater number of teeth in the older embryo coincided with the disappearance of these double teeth, which seem to split up into the simple conical teeth.

The Toothed Whales are not furnished with baleen, but with teeth only. These teeth are more or less numerous, their arrangement being of value in the classification of the group: a matter which is dealt with later.

In the Narwhal, whose dentition in the adult is reduced to the well-known tusk or tusks (properly developed only in the male), there is a complete foetal dentition. A very curious fact has been elucidated by Professor Kükenthal about the dentition of the Common Porpoise. It appears that in this Cetacean the two teeth corresponding to each other of the two dentitions may fuse into a single tooth, which has in consequence a double crown. It may be that this is the case with the Platanistid *Inia*, and that its diconodont teeth are not, therefore, a reminiscence of the comparatively complicated teeth of the ancient Zeuglodonts.

The internal organs of Whales which show the greatest peculiarities as compared with other mammals are the stomach, the lungs, and the diaphragm. Whales always possess a complicated stomach divided into many, but into a variable number of, chambers: there are as few as four in some, as many as fourteen in Ziphioids.

On account of its complication the stomach[1] has been compared to that of Ruminants—it has even been alleged that Whales "ruminate"—but the comparison will not hold good. Nor, on the other hand, is there a very close resemblance to the equally-complicated stomach of the Sirenians.

The Rorqual has a stomach with as few compartments as any. The only Whale which appears to have fewer is *Balaena mysticetus*, where there are but three. In the Rorqual the oesophagus opens into a more or less globular sac; from the upper end of this, *i.e.* close to the entry of the oesophagus, arises the second chamber, long and narrowish; then follows an extremely short third sac,

[1] For details and literature see Jungklaus, *Jen. Zeitschr.* xxxii. 1898, p. 1.

then a larger fourth, after which comes the dilated commencement of the small intestine. The latter might be regarded as a chamber of the stomach were it not for the fact that the ducts of the liver and the pancreas open into it. This represents one type of the Cetacean stomach, which seems to be found in all Whales except the Ziphioids. In the latter, the oesophagus opens into the first compartment as usual; but the second division of the stomach arises not close to the entrance of the oesophagus, but at the opposite end. It would seem, therefore, as if the first division of the stomach, found in most Whales, were missing in Ziphioids. This way of looking at the matter is confirmed by the fact that in *Hyperoodon* a remnant of the missing first stomach is found in the shape of a small diverticulum of the oesophagus just before it enters the stomach.

The essential difference between the Whale's and the Ruminant's stomach is this: in the latter the stomach is primarily divided into two portions, of which the first is non-digestive and is clothed with oesophageal epithelium. The second, the abomasum, is the digestive region. The first part is again divided into three compartments. In the Whales, on the other hand, it is the digestive part which is again subdivided, while if the first part is divided it is not markedly so as in the Ruminants.

The lungs are remarkable for their unlobulated character; in this they agree with the lungs of the Sirenia. The thoracic cavity in which they lie is barrel-shaped, and not, as is usual in terrestrial mammals, boat-shaped, *i.e.* narrower sternally than above. The alteration of the shape of the thoracic cavity is associated with the aquatic life; so at any rate the fact that it is also marked in Seals and even in the Otter seems to show. The Whales are also characterised by the great obliquity of the diaphragm, which is extremely muscular. In this character again we find an agreement with the Sirenia, and also with other aquatic mammals; it is not therefore a character of Whales so much as evidence of an adaptation to the aquatic life. The advantage is, it appears, in the increased capacity of the thoracic cavity, and the consequent greater possibilities of expansion of the lungs, which it must be remembered serve as hydrostatic as well as breathing organs.

Some of the internal arteries of Whales break up into retia mirabilia. Their kidneys are lobulated; whether this has

anything to do with the aquatic life is not so clear. It also characterises the Sirenia, more or less, and the Otters; but, on the other hand, the terrestrial Bears show the same structure as do also some Ungulates. It must be borne in mind, too, that the kidneys of foetal Man are lobulated.

The liver is a compact organ not showing such lobulation as is common, but not universal, among mammals.

The bones of Whales have a somewhat loose structure, and are much impregnated with oil. In many features the skeleton of Whales is highly distinctive of the order.

The brain case is small proportionately and rounded. The "face" is therefore long, and in some cases, especially among the fossil forms of Platanistidae, the rostrum is extraordinarily elongated. The asymmetry of the Whale's skull is one of its most remarkable features; this, however, is entirely limited to the Toothed Whales, and among them is more pronounced in some forms than in others. Thus the Platanistidae and many Ziphioids are not nearly so asymmetrical as the Dol-

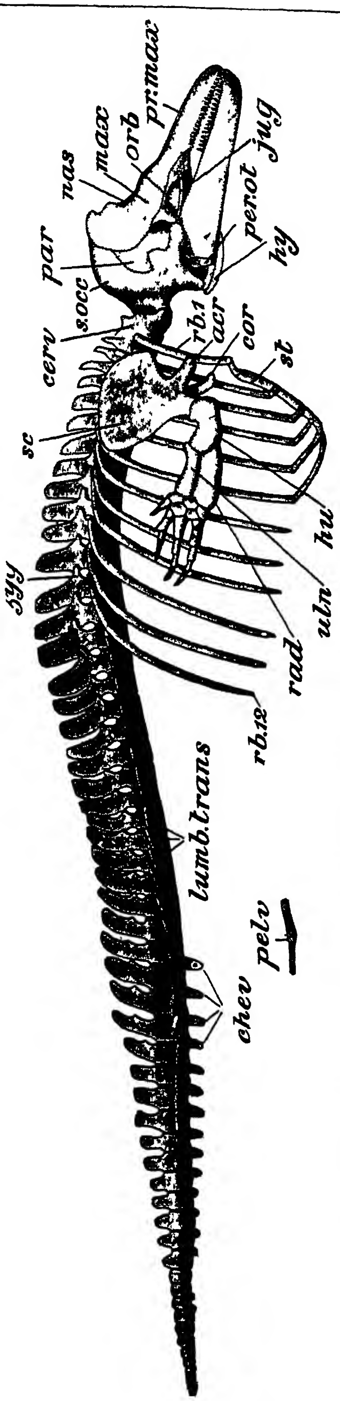

FIG. 183.—Skeleton of Porpoise (*Phocoena communis*). *acr*, Acromion process of scapula; *cerv*, united cervical vertebrae; *chev*, chevron bones; *cor*, coracoid process; *hu*, humerus; *hy*, hyoid; *jug*, jugal; *lumb.trans*, lumbar transverse processes; *max*, maxilla; *nas*, nasal; *orb*, orbit; *par*, parietal; *pelv*, vestige of pelvis; *per.ot*, periotic; *pr.max*, premaxilla; *rad*, radius; rb^1, first rib; rb^{12}, twelfth rib; *sc*, scapula; *s.occ*, supra-occipital; *st*, sternum; *uln*, ulna; *zyg*, prezygapophysis. (From Parker and Haswell's *Zoology*.)

phins and, especially, *Physeter*. This asymmetry affects particularly the premaxillae, the maxillae, and the nasals. The base of the skull is symmetrical. The Whale's skull has very long premaxillae which, however, do not, except in the extinct

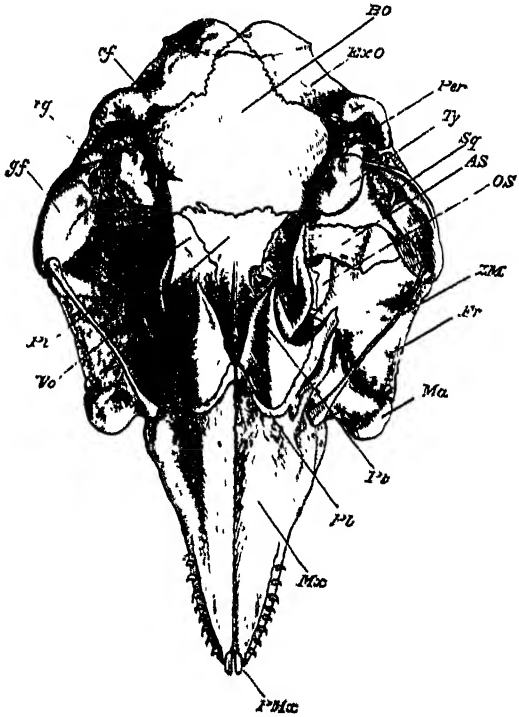

FIG. 184.—Under surface of the cranium of a young Caa'ing Whale (*Globicephalus melas*). × ⅛. *AS*, Alisphenoid ; *BO*, basioccipital ; *cf*, condylar foramen ; *ExO*, exoccipital ; *Fr*, supra-orbital process of frontal ; *gf*, glenoid fossa of squamosal ; *Ma*, body of malar ; *Mx*, maxilla ; *OS*, orbitosphenoid ; *Per*, posterior (mastoid) process of periotic ; *Pl*, palatine ; *PMx*, premaxilla ; *Pt*, pterygoid ; *Sq*, squamosal ; *ty*, deep groove on squamosal for meatus auditorius externus, leading to tympanic cavity ; *Ty*, tympanic ; *Vo*, vomer ; *ZM*, zygomatic process of malar. (From Flower's *Osteology*.)

Zeuglodonts, bear any teeth. The nasal bones, whether symmetrical or the reverse, are very small in existing Whales, which arrangement, together with the long and broad maxillary bones, removes the anterior nostrils, the blow-hole, far backwards. The roof of the skull is not at all formed by the parietals externally. These bones form a portion of the side of the cranium, but are replaced or covered by the enormously-

developed supra-occipital in the adult. Here again the Zeuglodonts are more typically Mammalian, for in them the parietals have a normal development and situation, rising even into a median crest as in so many quadrupeds. The bones related to the organ of hearing, the tympanics and petrous bones, are very solid and dense in structure Moreover they are but

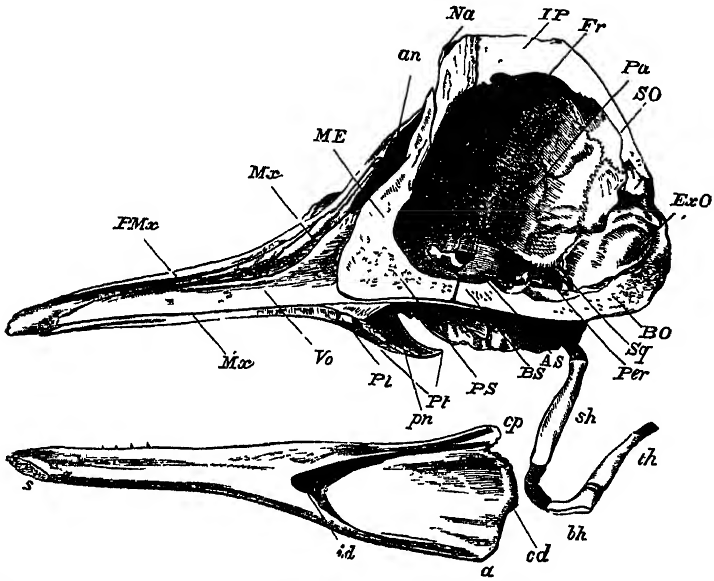

FIG. 185.—A section of a skull of a young Caa'ing Whale (*Globicephalus melas*). × ⅛. *a*, Angle ; *an*, anterior nares ; *AS*, alisphenoid ; *bh*, basihyal , *BO*, basioccipital ; *BS*, basisphenoid ; *cd*, condyle ; *cp*, coronoid process , *ExO*, exoccipital ; *Fr*, frontal ; *id*, inferior dental canal ; *IP*, interparietal ; *ME*, ossified portion of the mesethmoid ; *Mx*, maxilla , *Na*, nasal ; *Pa*, parietal , *Per*, periotic ; *Pl*, palatine , *PMx*, premaxilla ; *pn*, posterior nares , *PS*, presphenoid , *Pt*, pterygoid ; *s*, symphysis of mandible ; *sh*, stylohyal , *SO*, supra-occipital , *Sq*, squamosal ; *th*, thyrohyal ; *Vo*, vomer. (From Flower's *Osteology*)

loosely attached to surrounding bones, and are thus easily and frequently lost. Nearly the only mammals which resemble the Whales in the fact that the pterygoids sometimes meet in the middle line below are the Edentata (Anteater and Armadillo, see p. 167). But in both groups this peculiarity is not universal.

The vertebral column is remarkable for the fact that more or fewer of the cervical vertebrae may be fused together into a short and compact mass. This is seen at its maximum in the genera *Balaena* and *Neobalaena*. The odontoid process of the second

vertebra, though hardly at all marked, is nevertheless really present and developed from a bony centre of its own, as in other mammals. The dorsal and lumbar vertebrae are, of course, to be distinguished by the presence of ribs attached to the former, but

FIG. 186.—Section through middle line of united cervical vertebrae of Greenland Right Whale (*Balaena mysticetus*). × ⅙. *a*, Articular surface for occipital condyle, *e*, epiphysis on posterior end of body of seventh cervical vertebra; *sn*, foramen in arch of atlas for first spinal nerve; 1, arch of atlas; 2, 3, 4, 5, 6, conjoined arches of the axis and four following vertebrae, 7, arch of seventh vertebra. (From Flower's *Osteology*.)

as there is only a rudimentary pelvis, not attached to the vertebral column, no sacral region can be detected. The caudal vertebrae are to be recognised by the **V**-shaped chevron bones below.

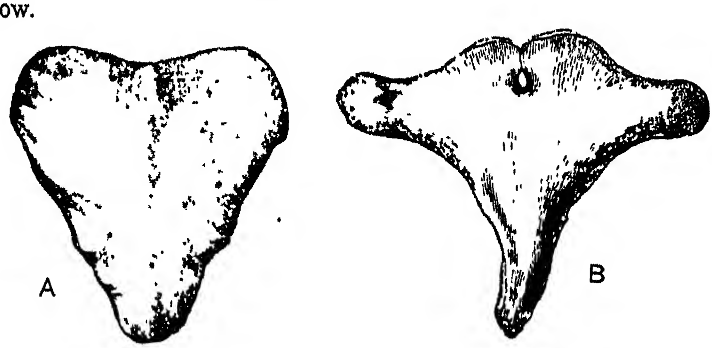

FIG. 187.—**A**, Sternum of Greenland Right Whale (*Balaena mysticetus*). × $\frac{1}{15}$. **B**, Sternum of Common Rorqual or Fin Whale (*Balaenoptera musculus*). × $\frac{1}{10}$. (From Flower's *Osteology*.)

The sternum in the Whale tribe is much more modified in the Whalebone Whales than in the Odontocetes. In the latter it is made up of several pieces, as in other mammals, which often, however, become coalesced. In the Mystacoceti this bone is a single piece, to which only one pair of ribs is attached, and its

form is characteristic of the genus. It is heart-shaped, more or less, in *Balaena*, and somewhat cross- or **T**-shaped in the genus *Balaenoptera*. In the Odontocetes the ribs have, some of them, the normal attachment by capitulum and tuberculum. In the Mystacocetes the attachment, where it exists, is very loose, and the tuberculum alone is attached to its vertebra. This allows of the freer play of the ribs during respiration. The scapula has a very characteristic form in these animals. The acromion, where it exists, is placed near the anterior margin of the shoulder blade, and overlaps the generally long coracoid process. Clavicles are totally absent. The pelvis is very rudimentary, consisting merely of a single bonelet, to which are attached the rudiments (in some cases) of a femur, and, in *Balaena* (Fig. 188), of a tibia also.

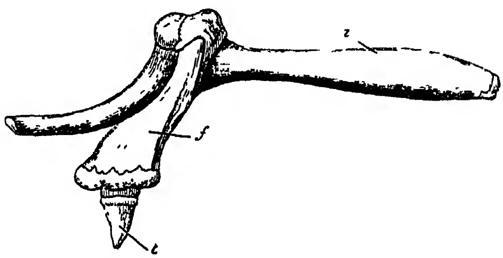

FIG. 188.—Side view of bones of posterior extremity of Greenland Right Whale (*Balaena mysticetus*). × ⅛. *i*, Ischium, *f*, femur; *t*, accessory ossicle representing the tibia. (After Eschricht and Reinhardt) (from Flower's *Osteology*.)

Whales are to be divided into three great groups:—(1) the Whalebone Whales or Mystacoceti; (2) the Toothed Whales or Odontoceti; and (3) the entirely-extinct Archaeoceti or Zeuglodonts.

SUB-ORDER 1. MYSTACOCETI.

This division is thus characterised:—Teeth are never functionally developed; they are present in the young, but replaced in the adult by the baleen or whalebone; the external respiratory aperture is double; the skull is perfectly symmetrical; the rami of the mandible are arched outwards and do not form a true symphysis; the sternum is always composed of a single piece of bone; the ribs articulate only with the transverse processes of the vertebrae.

The Mystacoceti are nearly invariably huge creatures, the sole exceptions being the Pygmy Right Whale, *Neobalaena*, and

a small Rorqual. But even these are larger than the majority of Toothed Whales.

The most characteristic feature by which the Whalebone Whales are to be distinguished from other Whales is that which gives to them their name, the presence of whalebone Whalebone is a horny product of the epithelium lining the mouth, and is comparable to an exaggeration of the transverse ridges which are found in the mouths of all mammals upon the palate. In non-Cetacean mammals these ridges vary in depth, and are arranged as a rule transversely, but with an oblique inclination. This is precisely how the plates of baleen are disposed in the mouth of a Whale. Each piece of "bone" is triangular in shape, the broader end being that of attachment while it narrows gradually; the inner side of the blades is frayed out into a number of threads which form the straining apparatus. The plates vary in length up to as great an extreme length as 13 feet, which occurs in the Right Whale at times. The colour is black or paler, even white. The number of these plates in the mouth is very great. As many as 370 blades have been counted. They diminish in length towards both ends of the series. Though whalebone has been in use for a long period, whence the whalebone came was formerly one of those things not generally known.

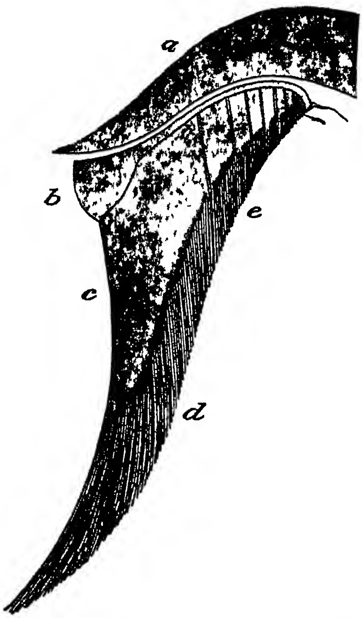

FIG. 189.—Section of upper jaw, with baleen plates, of *Balaenoptera*. *a*, Bone of jaw; *b*, gum; *c*, straight edge of baleen plate; *d*, *e*, frayed out surface of baleen plates. (After Owen.)

A very prevalent notion was that the whalebone formed the eyelids or perhaps the eyelashes of the creature. Scaliger, commenting upon Aristotle, held that the whale had "lamellae upon the eyebrows, which, when the head is plunged below the surface, were raised by the water; but when the animal raised its head

above the waves the lamellae fell and covered the eyes." Whalebone, too, has been often spoken of as "the fin of a whale," "the finnes that stand forth of their mouths." The value of whalebone is still great, in spite of various substitutes which are now used in its place. In the year 1897, for example, the value of this article was £2000 per ton. As a single Whale may produce several tons of this material, it is not surprising to find that the results of a whaling voyage may be very profitable.

Fam. 1. Balaenopteridae.—This genus *Balaenoptera* includes the Rorquals, which are Whalebone Whales of large size, differing from the Right Whales in three important external characters: the head is comparatively small; there is a dorsal fin; the throat is marked by numerous longitudinal furrows. The bones of the cranium are not so arched as in the Right Whales, and as a consequence the plates of baleen are shorter. The hand is only four-fingered. The cervical vertebrae are for the most part all free. One of the earliest records of a Whale stranded in the Thames was probably of a species of this genus in the year 1658, and is thus described by John Evelyn:—"A large whale was taken betwixt my land butting on the Thames and Greenewich, which drew an infinite concourse to see it, by water, horse, coach, and on foot, from London and all parts. . . . It was killed with a harping yron, struck in the head, out of which spouted blood and water by two tunnells, and after an horrid grone it ran quite on shore and died. Its length was 58 foot, heighth 16; black skinn'd like coach leather, very small eyes, greate taile, onely two small finns, a picked snout, and a mouth so wide that divers men might have stood upright in it; no teeth, but suck'd slime onely as thro' a grate of that bone which we call whalebone, the throate yet so narrow as would not have admitted the least of fishes . . . all of it prodigious, but in nothing more wonderful that an animal of so greate a bulk should be nourished onely by slime thro' those grates."

Professor Collett has recently given[1] an elaborate account of the characters and habits of this great Whale (*Balaenoptera musculus*). Though a large beast (44 to 67 feet in length) it is exceeded by other Rorquals; it is of a dark grey blue colour above, white, for the most part, below. The dorsal fin is large and high; the flippers relatively slender and small. The whole throat from the

[1] In *Proc. Zool. Soc.* 1886, p. 243.

symphysis of the jaws to the middle of the belly is, as in other species, marked by furrows, forty to fifty-eight in number. The hairy covering is reduced (in an adult female) to thirteen hairs on each side of the lower jaw; in a foetus there were also seven hairs on each side of the upper jaw, as well as rather more on the lower jaw—altogether, forty-eight. This Whale appears to feed chiefly upon small Crustacea, especially the Copepod, *Calanus finmarchicus*. The number of baleen plates is about 330 on each side of the jaw. This Whale sometimes swims singly, but usually in schools of even as many as fifty.

Rudolphi's Rorqual (*B. borealis*) seems to be a perfectly inoffensive beast; it is said to be able to stay under water for as long a time as twelve hours.

A smaller species than the last is *B. rostrata*—at the outside 33 feet in length. Here the hairy covering is reduced[1] to "two small hairs on the integument covering the apex of the lower maxilla." The colour is greyish black above, the underside white. On the other hand, *B. sibbaldii*, the Blue Whale, is the giant of its race, reaching a length of 85 feet. Its colour is a dark bluish grey, with small whitish spots on the breast. The dorsal fin is small and low with straight margins.

B. musculus, the Finner, is intermediate in size—not more than 70 feet. It seems doubtful whether the "sulphur bottom," *B. australis*, of Antarctica and *B. patachonica* differ specifically from this.[2]

The genus *Megaptera* is very near *Balaenoptera*, but differs from it mainly in the following external and internal characters. The dorsal fin is not very prominent, and its place is taken by a lowish hump, whence, indeed, the common name of this Whale, "Humpback." The pectoral fin is unusually long, and the creature uses it to beat itself, the surrounding water, and, more playfully, its mates. The general outline of this Cetacean is more clumsy than that of *Balaenoptera*. The most important internal difference is in the form of the scapula, which has at most a slight acromion and coracoid process. These are rather more pronounced, according to Messrs. van Beneden and Gervais,[3]

[1] Perrin, "Notes on the Anatomy of *B. rostrata*," *Proc. Zool. Soc.* 1870, p. 805.

[2] von Haast, "Notes on a Skeleton of *Balaenoptera australis*," *Proc. Zool. Soc.* 1883, p. 592.

[3] *Ostéographie des Cétacés*, Paris, 1880, p. 130.

in the southern form of the genus, which is known as *M. lalandii*. The head, it should also be remarked, is studded with large tubercles about the size of an orange, which seem to be hypertrophied rudiments of the hairs, which should be present in this region of the body. As is the case with other Whales, numerous species have been made out of individuals of *Megaptera*. Captain Scammon, who observed many "gams" or herds of these Whales, remarked[1] that he had extreme difficulty in finding any two individuals precisely alike! The best-known species in any case is the northern *M. longimana*, which occurs on our own coasts. The genus is, like so many Cetaceans, world-wide in range; and it is possible that the difference in the scapula already referred to may justify the separation of a southern *M. lalandii* (with which in that case, perhaps, *M. capensis* and *M. novae zelandiae* will be synonymous). Quite recently M. Gervais has insisted upon a *Megaptera indica* from the Persian Gulf. *Megaptera* grows to a length of 50 to 60 feet. Seventy-five feet have been stated, but measurements of Whales have usually to be received with caution.

Rhachianectes, with but one species, *R. glaucus*,[2] the "Californian Grey Whale," is the last genus of the family Balaenopteridae. This Whale is but imperfectly known anatomically; but quite sufficient has been ascertained to show its great divergence from *Balaenoptera* or *Megaptera*. The dorsal fin is completely absent, and the throat pleats, so characteristic of the typical Balaenopteridae, are reduced to two. It has, however, the general outline of a Rorqual, with a relatively small head. In osteological characters it tends to unite the two families Balaenopteridae and Balaenidae (if they are really necessary subdivisions). The skull is on the whole Rorqual-like; but its fore-part is narrow as in the Greenland Whale, and the premaxillaries are pinched up in the middle line so as to be visible from the side; this again is a Balaenid character. The cervical vertebrae are free as in Rorquals, and the sternum is quite as in that group. The scapula has more the shape of that of *Balaena*.

Rhachianectes glaucus is confined to the Pacific, and has been extensively hunted from the shore. It is not, however, a very valuable Whale, since the baleen is short as in Rorquals, and the

[1] *Marine Mammals of the North-West Coast of North America*, 1874.
[2] Cf Scammon, *loc. cit*

beast, moreover, appears to be fierce, a somewhat rare attribute of Whales. It has been spoken of, indeed, as "a cunning, courageous, and vicious" animal. *Rhachianectes* is essentially a coast Whale, and loves to lie in the surf in quite shallow water waiting for the tide to float it off. This Whale varies much in colour from black to mottled grey and black, and reaches a length of about 40 feet.

Fam. 2. Balaenidae. The Right Whales of the genus *Balaena* are to be distinguished from *Neobalaena* and from the Rorquals by the following characters:

The size is large, 50 to 60 feet. There is no dorsal fin. The head is more than or nearly one-fourth of the entire length of the animal. The baleen is very long. The throat is not grooved. The orbital process of the frontal is not wider than the downward process of the maxilla. The cervical vertebrae are all fused. The scapula is rather high. The hind-limb has the rudiment of a tibia. The intestine has no caecum.

A vast number of different genera have been founded on detached bones, bits of whalebone, and more or less complete skeletons of Right Whales coming from different parts of the world. In Dr. Gray's catalogues we find the following allowed, viz. *Balaena*, *Eubalaena*, *Hunterius*, *Caperea*, *Macleayius*. The number of "species" distributed among the genera is some thirteen or more, with whose names we shall not trouble the reader. As a matter of fact there are not more than two species which can with certainty be identified and distinguished, both of which are so close that they cannot possibly be placed but in the same genus, *Balaena*. In no group of Whales in no group of animals probably has imagination run riot to so terrible an extent in the formation of genera and species as in these Right Whales. This multiplication or rather division of genera has arisen from an old idea that Whales coming from different seas must be of different kinds, a notion now thoroughly exploded.

The term "Right Whale" simply means that the Whales of this genus are the right kind of Whale for the whaler to pursue. Their whalebone is longer and more valuable, while the oil is not only more abundant but of a superior quality. The two species demand a separate account.

The Greenland Whale, *Balaena mysticetus*, is one of the rare instances of a Whale which has an exceedingly limited range in

space. It is absolutely confined to the Arctic Ocean, and reported occurrences on our coasts are due to a confusion with *B. australis*, to be presently described. At the "Devil's Dyke," near Brighton, there is, or was, the skull of a most flagrant Rorqual, which is carefully labelled "Greenland Whale." This Whale grows to a length of 50, 60, rarely 70 feet. It is black in colour, save for a white patch on the under side of the jaw. The head is quite one-third of the body in length. There are a few scattered hairs at the extremity of the jaws. The length of time which this Whale can endure immersion has been variously stated. The utmost limit of endurance is stated by Scammon to be one hour and twenty minutes. The pursuit of this Whale is attended by dangers, not in the least because the animal is itself fierce and ready to attack, but simply on account of the velocity with which, and the great depth to which, it will dive, and also to the huge muscular force which is exerted in its struggles to free itself from the harpoons. It is indeed an extremely timid beast. It has been remarked that "a bird alighting upon its back sometimes sets it off in great agitation and terror." Combined with this timidity of disposition is an intense affection for its young, "which would do honour," observed Scoresby, "to the superior intelligence of human beings." Yet that trader and observer goes on to remark that "the value of the prize . . . cannot be sacrificed to feelings of compassion"! The fact that this Whale and its congener, *B. australis*, feed among swarms of minute pelagic creatures, which they engulf in their huge mouths, led the ancients to believe and assert that they fed upon water only. When the Whale feeds it moves along with some velocity, taking in huge mouthfuls of sea water with the contained organisms, which are then strained off by the whalebone and left stranded upon the tongue .

Unlike its congener, the southern Right Whale, *B. australis*,[1] is world-wide in distribution, avoiding only the Arctic regions. Where the Greenland Whale is found *B. australis* does not exist. The principal differences which it shows from *B. mysticetus* are firstly in the relatively shorter head and shorter and coarser whalebone. In the second place it has more ribs, fifteen pairs as against thirteen; but there is apparently some little confusion in the matter of ribs. An additional rib at the end of the series

[1] The name that has priority seems to be *glacialis*

is apt to get lost, and in the skeleton of so huge and unmanageable a beast there is nothing more unwise than to insist upon, as specific characters, what may be due merely to defective preparation. This Whale has often, and the Greenland Whale also, a rough horny protuberance upon the snout known as the "bonnet." The causation of this is not clear. It has been spoken of as "a rudimentary frontal horn." But this suggestion of an Ungulate affinity can hardly be accepted. It seems to be more like a kind of corn.

This Whale was once more abundant on the coasts of Europe than it is to-day; it was much hunted by the Basques in past time. The Whale which frequented the Bay of Biscay was usually called the Biscayan Whale or *B. biscayensis;* but there is probably no specific difference. Among the small towns which fringe the Bay, it is very common to find the Whale incorporated into the armorial bearings. "Over the portal of the first old house in the steep street of Guetaria," writes Sir Clements Markham,[1] "there is a shield of arms consisting of Whales amid waves of the sea. At Motrico the town arms consist of a Whale in the sea harpooned, and with a boat with men holding the line." Plenty of other such examples testify to the prevalence of the whaling industry on these adjoining coasts of Spain and France. It appears that though the fishery began much earlier—even in the ninth century—the first actual document relating to it dates from the year 1150. It is in the shape of privileges granted by Sancho the Wise to the city of San Sebastian. The trade was still very flourishing in the sixteenth century. Rondeletius the naturalist described Bayonne as the centre of the trade, and tells us that the flesh, especially of the tongue, was exposed for sale as food in the markets.

M. Fischer,[2] who, as well as Sir Clements Markham, has given an important account of the whaling industry on the Basque shores, quotes an account of the methods pursued in the sixteenth century. It was at Biarritz—or as Ambroise Paré, from whom Fischer quotes, spelt it, Biaris—that the main fisheries were undertaken. The inhabitants set upon a hill a tower from which they could see "the Balaines which pass, and perceiving them coming partly by the loud noise they make, and

[1] *Proc. Zool. Soc.* 1881, p. 969.
[2] *Actes Linn. Soc. Bordeaux*, 1881.

partly by the water which they throw out by a conduit which they possess in the middle of the forehead." Several boats then set out in pursuit, some of which were reserved for men whose sole duty it was to pick out of the water their comrades who had overbalanced themselves in their excitement. The harpoons bore a mark by which their respective owners could recognise them, and the carcase of the animal was shared in accordance with the numbers and owners of the harpoons found sticking in the dead body of the Whale. At this period the fishery was at its height. But it continued to be an occupation along those shores until the beginning of the eighteenth century, after which it gradually declined. The fishery of Whales began to be carried farther afield than the shore, and for a long time the Basques furnished expert harpooners to whaling vessels proceeding to the Arctic seas. A curious example of the continuance of the fishery until at least 1712 is given by Sir C. Markham. In the parish records of Lequeito for that year, it is noted that a couple were married who possessed between them all the necessary outfit for a whaling cruise.

The genus *Neobalaena* is interesting from more than one point of view. Its size compared with its gigantic relatives is small, some 16 or 17 feet. The genus bears the same kind of proportion to *Balaena* that *Kogia* does to *Physeter* among the Physeteridae. It is one of those Whales which are very restricted in habitat; up to the present it is only known from the Antarctic region in the neighbourhood of New Zealand and South Australia. Structurally it is in a few points intermediate between the Right Whales and the Rorquals. The head is proportionately (as well as, of course, actually) not so large as in *Balaena*. There is a falcate dorsal fin; but the head in outline is not Rorqual-like in spite of its similar proportions. The whalebone is long. The throat is not grooved. *Neobalaena* has forty-three vertebrae, of which the cervicals are all fused. There are as many as seventeen or eighteen dorsal vertebrae, the largest number in any Cetacean as far as is known. With these are articulated not eighteen but only seventeen ribs. The first dorsal vertebra appears to be without a rib. The ribs are very broad and flat. The body thus gets an appearance of a Sirenian. The lumbar vertebrae are fewer than in any other Cetacean, being only two. The scapula is more like that of the Rorquals than that of the Right Whales;

that is to say, it is long and not very high. The skull is most like that of *Balaena*, but the process of the frontal arching over the eye is broader relatively than in *Balaena*, and thus approaches *Balaenoptera*. Nothing is known of the viscera of this Whale. The whalebone is white, and the animal was first described by Dr. Gray from pieces of "bone." It is not always that so fortunate a diagnosis of specific or generic difference has been made from a structure which apparently offers so little aid for discrimination.

There is but a single species of the genus which is named *Neobalaena marginata*.[1]

SUB-ORDER 2. ODONTOCETI.

The *Odontoceti* have teeth but no whalebone; the blow-hole is single; the skull is not symmetrical; some of the ribs are two-headed.

Fam. 1. Physeteridae.—This family of the Odontocetes may be thus defined:—All or most of the cervical vertebrae are fused together. The costal cartilages are not ossified. In the skull the pterygoids are thick and meet in the middle line; the symphysis of the mandible is long. Teeth, more or fewer, are found in both jaws, but those of the mandible are alone functional (? exc. *Kogia*). The pectoral limb is smallish. The throat is grooved by two or four furrows.

This family of Whales is again susceptible of division into the two sub-families—Physeterinae or Sperm Whales and the Ziphiinae or Beaked Whales. Professor P. J. van Beneden was strongly against any subdivision of what is here regarded as a perfectly natural family, embracing the Physeters and the Beaked Whales. There are, however, some reasons for the subdivision. The Ziphiinae have a reduced series of teeth, never exceeding two on each mandible, which contrasts with the fully-toothed mandibles of both *Physeter* and *Kogia*. The stomach of the Ziphioids is extraordinarily complicated even for a Cetacean. The small head of the latter group, which recalls in a curious way that of Mosasauroid reptiles and some Dinosaurs, is in contrast to the

[1] For osteology see Hector, *Trans. New Zeal. Inst.* vii. 1876, p. 251; and Beddard, *Trans. Zool. Soc.* xv. 1901, p. 87.

enormous head of the Cachalot and the very fairly-developed skull of the "Pygmy Sperm Whale." Both, however, furnish spermaceti, and in various osteological details come near together. On the whole we incline towards separating the Cachalots from the Ziphioids, and shall therefore commence with the former as being in some respects the more primitive members of the family Physeteridae.

Sub-Fam. 1. Physeterinae.—This sub-family may be thus defined:—Teeth in lower jaw numerous. No distinct lachrymal bone. Stomach with only four compartments (? as to *Kogia*).

Of this sub-family the best-known genus is *Physeter*, including the Sperm Whale or Cachalot. Of other reputed species we shall speak later. The genus is characterised in the first place by its large size—as much as 82 feet of length have been assigned to *Physeter macrocephalus;* but Sir William Flower thought that 55 or possibly 60 feet might be a better approximation to the greatest length of the Cachalot. The head is enormous, a third of the length of the body, and terminates in a massive and bluntish snout. This is, however, not so abruptly truncated as is often represented in figures. According to Messrs. Pouchet and Chaves,[1] it slopes forward two metres beyond the end of the lower jaw; the mouth is thus ventral and almost shark-like in position, as is the case also with the Pygmy Sperm Whale, to be considered later. In connexion with this peculiar position of the mouth, it has been asserted—Mr. F. T. Bullen figures it[2]—that the Sperm Whale turns over upon its back to bite. The blow-hole is single, and shaped like the sound-hole of a violin; it lies upon one side, and is not median in position. The throat is grooved as in the Ziphioids by two grooves. The dorsal fin is represented by a whole series of lowish humps, decreasing in elevation from before backwards. The pectoral fins are not large relatively speaking. The great square head is not occupied entirely by the skull; the cavity lying above, which is of course traversed by the tube ending in the blow-hole, is filled with the spermaceti, which is fluid fat during the life of the animal. Spermaceti also occurs in other Whales; and that of *Hyperoodon*, whence it has been extracted for commercial purposes, is said to offer no differences of importance from the spermaceti of the

[1] *Journ. de l'Anat.* xxvi. 1890, p 270.

[2] *The Cruise of the Cachalot*, London, 1900.

Sperm Whale. Spermaceti as a drug appears to have been first mentioned in the pharmacopoeias of the famous medical school of Salerno towards the year 1100. But it was confounded with a totally distinct substance, viz. ambergris. The confusion was also made by the famous alchemist Albertus Magnus, and by the observant Archbishop of Upsala, Olaus Magnus, in his work *De gentibus septentrionalibus*. It was supposed in fact by these writers to be the liberated sperm of the Whale, hence obviously the name. Later on, the substance in question was regarded as the brain of the Cachalot, in fact as late as the middle of the eighteenth century. It was Hunter and Camper who really discovered the true nature of the substance, oil of course, in the cavities of the skull.[1] The huge skull of *Physeter* "is perhaps the most modified from the ordinary type" of skull in the whole mammalian class.

The top of the skull rises into a huge crest lying transversely, and from it slope forward two lateral crests formed from the maxillary bones; in this great basin lies the spermaceti already referred to. The skull, as in Toothed Whales generally, is exceedingly asymmetrical. The right premaxillary and the left nasal bones are much larger than their fellows; indeed the right nasal is hardly present as a separate bone. The parietal if present is fused with the supra-occipital. The jugal is large, and is not divided into two pieces as it is in the Ziphioids. The pterygoids meet below for a considerable distance, as in many Dolphins, and in the Edentata among other mammals. The symphysis of the lower jaw is very long, but the bones do not appear to be ankylosed. The length of the symphysis recalls that of the Gangetic Dolphin, *Platanista*.

In the vertebral column the atlas alone is free, the remaining cervicals being fused. There are only eleven dorsal vertebrae, eight lumbars, and twenty-four caudals. The breastbone of this Whale is a roughly-triangular bone made up of three pieces. Four cartilaginous sternal ribs are attached to this bone. The scapula is remarkable for the fact that it is concave on the outer and convex on the inner surface; otherwise it is quite typically Cetacean in form. The shortness of the pectoral limb is shown by the phalangeal formula, which is as follows:— I 1, II 5, III 5, IV 4, V 3.

[1] See Pouchet, "Contribution a l'histoire du spermaceti,' *Bergens Museums Aarbog for 1893*, No. 1.

One of the reasons for the pursuit of the Sperm Whale is the desire to obtain that extremely valuable product ambergris. This substance has long been known; but its true nature was for centuries in dispute. In Dr. Johnson's *Dictionary* (so recently as the edition of 1818!) ambergris is provided with alternative definitions; it is either the excrement of birds washed off rocks, or honeycombs that have fallen into the sea!

An old writer asserted of ambergris that it was "not the scum or excrement of the whale, but issues out of the root of a tree, which tree, howsoever it stands on the land, alwaies shoots forth its roots towards the sea, seaking the warmth of it, thereby to deliver the fattest gum that coms out of it, which tree otherwise by its copious fatness might be burnt and destroyed." These "explanations" were caused by the fact that ambergris is sometimes found floating in the sea. Ambergris is, of course, a product of the intestinal canal of the Sperm Whale; it seems to be of the nature of cholesterin, and its place of origin was conclusively proved by finding the beaks of cuttle-fish imbedded in it. When first extracted from the alimentary canal it is of greasy feel and consistency; later it hardens, and acquires its characteristic sweet earthy odour. Ambergris is used mainly as a vehicle for scents, and is a costly substance. A piece weighing 130 lbs. was valued at £500. Though now entirely used in connexion with perfumery, it was held by the ancients to be of great value as a specific in certain diseases.

The Sperm Whale is chiefly a tropical animal. Examples that have been cast up on our shores are strayed individuals. It often goes about in herds, which seem to be composed of females. Its food is chiefly cuttle-fishes, and it is said to have a predilection for those colossal cuttle-fishes whose existence has until recently been doubted. Mr. Bullen has sketched a conflict between these two giants of the deep. On the other hand it is said that its large throat, more than big enough to swallow a man (the Whale is credited with being that which swallowed Jonah), does not usually admit fishes larger than Bonitos and Albacores.

The ferocity of the Cachalot has been denied and affirmed. It certainly has great strength, for it can throw itself completely out of the water. Captain Scammon thinks that ships which are mysteriously lost at sea, with no obviously assignable cause, are sometimes the victims of the furious rushes of a bull

Sperm Whale. Marco Polo took much the same view, but suggested that the Whale did not deliberately attack the ship, but was deceived by the foam following in its wake into thinking "there is something to eat afloat, and makes a rush forward, whereby it shall often stave in some part of the ship."[1]

Sir W. Flower and many others are of opinion that there is but one species of Cachalot. But many names have been given to supposed other forms. The genus itself has even been divided, and to a set of vertebrae from the south Dr. Gray gave the perfectly superfluous name of *Meganeuron krefftii*. The "High-finned Cachalot" rests mainly upon the suggestions of Sir Robert Sibbald. It is supposed to have a high dorsal fin, and teeth in the upper as well as in the lower jaw. Common though it was asserted by its describer to be, there is not a bone, not a fragment even of a bone, alleged to belong to *Physeter tursio* in any museum in the world! It seems premature, therefore, to include this mysterious creature in any list of Cetacea, though that was done by no less a naturalist than the late Mr. Thomas Bell. It is this creature round which most of the stories of ferocity congregate. It is held to be the monster from which Perseus delivered Andromeda, and which was about to devour Angelica upon the shore of Brittany. The fact of the matter is, that the Sperm Whale, like so very many other Whales, is world-wide in range; and those naturalists who did not believe in so wide a distribution found themselves obliged, in order to satisfy their own views, to create new species for those of distant localities. Hence the dozen or so of synonyms which refer to what is to be called *Physeter macrocephalus*.

The genus *Kogia* (sometimes written *Cogia*), the so-called "Pygmy Sperm Whale," is a southern form of much smaller dimensions than its gigantic ally just described. *Kogia* does not exceed 15 feet or so in length. It differs from *Physeter* also in the well-marked and falcate dorsal fin, in its generally delphinoid form, in the short snout, and the more normal (for a Whale) shape of the blow-hole, which is crescentic.

There are also a number of osteological characters in which the two Physeterines differ from each other. In *Kogia* all the cervical vertebrae are ankylosed together; the skull is short, though equally asymmetrical; the ribs are as many as twelve or

[1] Yule, *Travels of Marco Polo*, ii. London, 1871, p. 231.

fourteen; the scapula has not the concave face that it has in *Physeter*. The functional teeth of the lower jaw seem to be reinforced by two on each side of the upper jaw. Moreover, the articulation of the ribs with the vertebrae does not show the very anomalous state of affairs that characterises *Physeter*, where the two heads of a rib may be upon one vertebra.

While there is no doubt as to the generic distinctness of *Kogia*, there is again the same difficulty that is met with throughout the whole of the order in settling into how many species the genus requires dividing.

We can dismiss, as unnecessary, additional generic names (*Euphysetes*, *Calignathus*), but there do appear to be reasons for allowing two species, if the accounts of their osteology are to be depended upon. One of these is *K. breviceps*, with thirteen pairs of ribs, no teeth in the upper jaw, fourteen or fifteen on each side of the lower jaw, vertebral formula C 7, D 13, L 9, Ca 25, and phalangeal formula I 2, II 8, III 8, IV 8, V 7.

The other will then be *K. simus*, with fourteen pairs of ribs, two teeth in the upper jaw, nine in each ramus of the lower jaw, vertebral formula C 7, D 14, L 5, Ca 24, and phalangeal formula I 2, II 5, III 4, IV 4, V 2.

A Californian species has been called *K. floweri*, whose teeth seem to be particularly long and recurved. And the New Zealand *K. pottsi* has been held to be also a distinct form. There seems to be nothing of special interest to record about the way of life of these Cetaceans, which are but imperfectly known.

Sub-Fam. 2. Ziphiinae.—Teeth in the lower jaw not more than two on each side. A distinct lachrymal bone. Stomach with very numerous compartments.

These Whales are all of moderate size, not exceeding 30 feet or so in length. They have a falcate dorsal fin rather near the end of the body; the muzzle is prolonged, hence the name often given to them of "Beaked Whales." The throat is grooved; the blow-hole is single and median, crescentic in form, with the concavity pointing forwards. A character possibly differentiating the Ziphioids from other Whales is the fact that the body ends in a rounded projection between the flukes of the tail. This has at any rate been noted in *Mesoplodon*, *Ziphius*, and *Hyperoodon*. The Ziphioid Whales are by no means common; indeed of *Berardius* but four or five specimens have ever been

met with. Most of them are southern in range, and the vast stretches of desolate coast which occur in these regions of the world account possibly for the rarity of their remains. These Whales have done duty more than once for the "Sea Serpent." Quite recently an alleged sea serpent turned out to be a couple of *Mesoplodon* lying head to tail! The head in these Whales is small compared to the body. The skull is characterised by the strong maxillary crests, enormously developed in the male *Hyperoodon*. The vertex of the skull too is raised, forming a pronounced prominence behind the aperture of the nares (blow-hole); in many forms the rostrum is made of very dense bone, and is thus relatively abundant in rock strata. The pterygoids meet in the middle line as in the Cachalot. In addition to the few functional teeth in the lower jaw there are more numerous but small teeth in the upper jaw. These are not always to be recognised, as they are not attached to the bone, but merely imbedded in the gums, so that they come away when the skull is prepared.

The genus *Berardius*[1] differs from *Mesoplodon* by its rather more symmetrical skull, of which the vertex is formed by the nasals. The mesethmoid is only partly ossified. The teeth are two on each side of the mandible, with their apices directed forwards. The vertebral formula is C 7, D 10, L 12, Ca 19.

B. arnouxi, from the seas of New Zealand, is the only species of this genus which is well known. It is 30 or 32 feet in length, and is of a velvety black colour, with a greyish belly. Instead of lowing like a cow, this Whale has been described as "bellowing like a bull"! A singular and somewhat inexplicable fact has been stated of this species. The teeth were said to be protrusible, and Sir James Hector stated that the teeth were imbedded "in a tough cartilaginous sac which adheres loosely in the socket of the jaw, and is moved by a series of muscular bundles that elevate or depress it." Sir William Flower justly observed that these statements "accord so little with anything hitherto known in mammalian anatomy that further observations on the subject are extremely desirable." Like other Ziphioids, *Berardius* feeds mainly, if not entirely, upon cuttle-fish, a prey eminently suited to their almost toothless mouths. It is not known whether *Berardius* has the

[1] See Flower, *Trans. Zool. Soc.* viii. 1872, p. 203.

Ziphioid grooves upon the throat. Nothing is known of the structure of the internal viscera of this Whale. It appears not to be really limited to the region of New Zealand, as is often stated, for Malm has lately described a skull (*Berardius vegae*) from Bering's Straits.[1]

Mesoplodon[2] is a world-wide genus embracing a number of species; on the lowest estimate seven species can be distinguished, and Sir W. Flower would add two more. These are moderate-sized Whales, 15 to 17 feet in length. In the skull the mesethmoid is ossified; the nasals are sunk between the upper ends of the premaxillae. There are but a single pair of teeth in the mandible attached to nearly the middle of its length (whence the generic name). The vertebral formula is C 7, D 9 or 10, L 10 or 11, Ca 19 or 20. The sternum consists of four or five pieces. The amount to which the cervical vertebrae are fused varies; but some are always fused.

The only species which has ever been stranded on the shores of this country is *M. bidens*, an example of which was described many years ago as the "Toothless Whale of Havre"; it was an old animal which had probably lost its teeth. Nevertheless it received the separate generic and specific name of *Aodon dalei*. The animal lived for two days out of the water, and made a sound like the "lowing of a cow." An instance of the rarity of the Whales of this genus is afforded by *M. europaeus*, of which only a single skull is known; this was extracted from a dead body, found floating, about the year 1840. It has never appeared since. *M. layardi* is remarkable on account of the very large size of its strap-shaped teeth; these curve over the upper jaw in such a way as to prevent the animal from fully opening its jaws. The case is curiously paralleled by the Sabre-toothed Tiger. This species is antarctic in range. From the opposite extremity of the globe comes *M. stejnegeri*, again known by but a single skull. It is singular on account of the large size of the brain case, and is a native of Bering's Straits. *M. hectori* has its two teeth situated quite at the extremity of the mandible, and in this feature approximates to the genus *Berardius*. It was, indeed, confounded with that genus by one naturalist.

[1] *Bihang Svensk. Akad. Handl.* viii. 1883.

[2] Flower, *Trans. Zool. Soc.* x. 1878, p. 415; and H. O. Forbes, *Proc. Zool. Soc.* 1893, p. 216.

Ziphius is a genus which is also of world-wide range. Here again the number of species is at present merely a matter of opinion. The prevalent impression, however, is that but a single species exists, which will therefore have the name of *Z. cavirostris*. The genus (and for the matter of that the species too) may be thus characterised in comparison with its allies. The mesethmoid is ossified as in *Mesoplodon*, but the nasals joined together form the vertex of the skull. There are two teeth near the symphysis of the mandible, besides the usual small and "functionless" teeth in the upper jaw. The vertebral formula is C 7, D 9 or 10, L 11, Ca 21.

The throat of a *Ziphius* from New Zealand was described by Messrs. Scott and Parker[1] as having three grooves on each side Whether this form is the same as von Haast's *Z. novae zelandiae* is a matter of doubt; but the individual to which his name has been applied was 26 feet long, and had but a single groove on each side. Even in the external characters of many Whales many points require clearing up. Our knowledge of *Ziphius* dates from the year 1804, when a skull "completely petrified in appearance" was picked up upon the Mediterranean coast of France, and described by the great Cuvier. It was forty years before another specimen was found. In the New Zealand specimen of von Haast already referred to, the body was scored by numerous lacerations. These wounds may have been due to fights among the Whales themselves; the forwardly-situated teeth would be capable of inflicting such wounds. But it has also been stated that the armed suckers of gigantic cuttle-fish are responsible for these scratches.

Hyperoodon is the most easily-distinguishable genus of Ziphioid Whales. Its characters are the following:—The skull has enormously-developed maxillary crests in the adult male; the mesethmoid is not fully ossified. There is but a single tooth to each ramus of the lower jaw, besides, of course, the usual small teeth in the upper jaw. The vertebral formula is C 7, D 9, L 9, Ca 18. The cervicals are fused into one mass, more or fewer being free in other Ziphioids. The sternum consists of three pieces only, the last of which is bifid posteriorly.

The name *Hyperoodon* was given to this Whale by Colonel Lacepède on account of the rough papillae upon the palate, which

[1] *Trans. Zool. Soc.* xii. 1889, p. 241.

were mistaken by that observer for teeth. It is curious that the name is really appropriate in spite of this mistake, though of course it would be so to all the Ziphioids. In more than one feature this genus comes nearest of all the Ziphiinae to *Physeter*. Its enormous maxillary crests are paralleled in that Whale; but in *Hyperoodon* their great thickness contrasts with the thinness of those of the Cachalot. The correspondence in the attachment of a rib to its vertebra by both heads is noteworthy. It is remarkable that in this particular *Hyperoodon* is more like *Physeter* than the supposed nearest ally of the latter—*Kogia*.

Of this genus two species are known. The best known is the common northern *H. rostratum* (with many aliases); the second species from the southern hemisphere, *H. planifrons*, is only known from a single water- and pebble-worn skull. Its identification, however, depends upon the known accuracy of the late Sir William Flower.

The northern species (*Hyperoodon rostratum*) has often been recorded upon our own coasts; the first record of the stranding of this Whale was in the year 1717. In that year an example was found at Maldon, in Essex. Like the Beluga, *Hyperoodon rostratum* gets lighter in colour with advancing years. The young are black, the old animals pale brown with some white about them. The under surface, however, is always greyish white. The length of this Whale reaches to at any rate 30 feet. But John Hunter had a specimen which he believed to be 40 feet in length. The specimen, however, consisted only of a skull, so that error might have crept in. It has already been mentioned that the old males have enormous maxillary crests. According to M. Bouvier, who has lately made an exhaustive examination of the anatomy of this Whale,[1] the females occasionally exhibit the same crests, which are thus presumably of the nature of spurs sometimes seen in old females among the Gallinaceous birds. The number of grooves upon the throat is in dispute in this Whale as in *Ziphius*. One pair is the usual allowance; but Kukenthal found four in some embryos studied by him. Attention has already been called to the voice of Ziphioid Whales. *Hyperoodon* neither "lows" nor "bellows," but "sobs"! *Hyperoodon rostratum* is a gregarious Whale, going about in herds, or "gams" as they should technically be termed, of four to ten or even fifteen. This Whale

[1] *Ann. Sci. Nat* (7), xiii. 1892, p. 259.

can leap right out of the water, and while in the air can turn its head from side to side, a capability which has not been mentioned in any other Whale. It can also stay under water for an unusually long period. Captain Gray,[1] who has made an accurate study of this species, states that so long a period as two hours is the limit of endurance; this event occurred in the case of a harpooned Whale.

Fam. 2. Delphinidae.—This family, which includes the greater number of Cetacea, may thus be characterised:—Whales of small to moderate size. Teeth as a rule numerous, and present in the upper as well as in the lower jaw. Maxillae without large crests; the pterygoids, often meeting in the middle line, enclose an air space open behind. The anterior (five to eight) ribs are two headed, the posterior with tubercular head only. The sternal ribs are ossified.

The Dolphins and Porpoises, as already stated, embrace the greater number of existing species of Whales. Sir W. Flower and others who have followed him, allow nineteen genera. But as to the exact number of known species there is much uncertainty. That very careful observer, Mr. True, considers[2] that there are fifty which demand recognition. As many as one hundred have received names. The matter is one which is perhaps barely ripe for decision. All the Dolphin tribe are, for Whales, smallish animals. The Killer Whale, *Orca*, is the only genus (or species?) which usually attains to more than moderate bulk. The rather mysterious *Delphinus coronatus*, 36 feet in length, of M. de Fréminville, would seem to be a Ziphioid; it was described as having a very pointed beak, and as having the dorsal fin situated near the tail; such characters suggest a *Mesoplodon*.

The genus *Delphinapterus*, the Beluga or White Whale, consists of but a single species, though as usual more than one name has been given to supposed different species. It is characterised as a genus by the following assemblage of structural features:—It has only eight to ten teeth occupying the anterior part of the jaws only. All the cervical vertebrae are free and unjoined. The vertebral formula is C 7, D 11 (or 12), L 9, Ca 23. The pterygoids are wide apart, though they converge as if about to meet at their posterior ends. There is no dorsal fin. The colour is white.

[1] *Proc. Zool. Soc.* 1882, pp. 722, 726.
[2] *Bull. U.S. Nat. Mus.* No. 36, 1889, p. 7.

The Beluga is a northern species purely. The reputed form, *D. kingii*, was said to come from Australian seas; but there seems to have been an error in this statement. It is interesting to note that the white colour, so characteristic of the genus and species, is not found in the young, which are blackish. They gradually pale as they advance towards maturity. *Delphinapterus leucas* reaches a length of 10 feet, and like other Porpoises will ascend rivers in search of food. It is said to be specially addicted to salmon. Among the contents of the stomach have been found quantities of sand. But this habit of swallowing sand or pebbles has been noted in other Whales. Whether it is or is not accidental (taken in with ground-living food), it seems hardly likely that it is used for purposes of ballast! The Beluga has a voice; but the name "Sea Canary" is hardly suitable to it. A specimen of this species, recently described from the shores of Scotland (it is often thrown up upon our coasts), which had got entangled in the stakes of a new net, was regarded by the natives, on account of its white colour, as a ghost. Externally, besides its colour, the Beluga is remarkable for possessing a distinct neck, which is correlated of course with the freedom of the cervical vertebrae, and is also seen in Platanistidae.

The Narwhal (*Monodon*) is closely allied in structure to the last genus. It has the following anatomical characters:—The teeth are reduced to a single "horn" in the upper jaw, which is rudimentary in the female. The neck vertebrae are free. The vertebral formula is C 7, D 11, L 6, Ca 26. The pterygoids are as in *Delphinapterus*, and, as in that genus, there are no hairs upon the face or dorsal fin.

This genus is of course most obviously characterised by the twisted tusk of the male, which is occasionally double. This tusk has given to the only species of the genus, *M. monoceros*, both its generic and specific name. The animal has a spotted colour; but, as in the case of the Beluga, old animals tend to become white. The use of its horn to *Monodon* has been debated. In the first place it is clearly a secondary sexual character. The males have been observed to cross their horns like rapiers in a fencing match. It may be that they are used in more serious combats. An ingenious suggestion is that the long and strong tusk enables its possessor to break the thick ice and

make a breathing hole. A third suggestion is due to Scoresby, who was led to make it from having taken out of the stomach of a Narwhal a large skate. He held that with its tusk the Whale empaled the fish and then swallowed it. The Narwhal is not large, 15 feet or so in length. But Lacepède, who was apt to compile with lack of discrimination, speaks of 60 feet long Narwhals. *Monodon* is purely Arctic, and but three or four specimens have ever been cast up on our shores.

Of true Porpoises, genus *Phocaena*, there are apparently several species. The genus itself has the following characters:—The teeth are sixteen to twenty-six on each half of each jaw; their crowns are compressed and lobed. The pterygoids do not meet. The dorsal fin has a row of tubercles along its margin.

The Porpoise of our coasts, *P. communis*, is a smallish species 6 to 8 feet in length. There are two to four hairs present in the young; its colour is black, generally lighter on the belly. The first six cervical vertebrae are fused. The ribs vary in number from twelve to fourteen pairs. It is a gregarious Whale, and will ascend rivers; it has been seen for example in the Seine at Paris. The name Porpoise is often written Porkpisce, which of course shows its origin. Very conveniently it was regarded as a fish, and therefore allowed to be eaten in Lent. The celebrated Dr. Caius, a gourmet as well as a physician and the refounder of a college, invented a particular sauce wherewith to dress this royal dish. Some time since Dr. Gray described a Porpoise from Margate as a distinct species (see p. 342) on account of the tubercles, which are now known to be a generic character.

Dr. Burmeister's *P. spinipennis* seems, however, to be really distinct. It was captured near the mouth of the Rio de la Plata. It is more tuberculated on the fin and back, and has fewer teeth (sixteen as against twenty-six).

Mr. True's *P. dallii* of the Pacific (where the Common Porpoise also occurs) is characterised chiefly by its very long vertebral column, consisting of ninety-eight vertebrae; there are only sixty-eight in the other species. The Eastern genus *Neomeris* is placed with *Phocaena* by Dr. Blanford. It practically only differs by the absence of a dorsal fin. It is only about 4 feet long, and inhabits the seas of India, Cape of Good Hope, and Japan. The one species is called *N. phocaenoides*.

The genus *Globicephalus* is to be defined thus:—Teeth

seven to twelve on each side, confined to anterior end of jaws. Skull raised into a prominence behind the blow-hole; pterygoids large and in contact. Pectoral fin long and falcate; dorsal fin present. No beak. Vertebral formula C 7, D 11, L 11 to 14, Ca 27 to 29. Six pairs of the ribs are two-headed.

The best known species of the genus is the Ca'ing Whale, *G. melas*.[1] This animal reaches a length of 20 feet, and is thus one of the largest of the Delphinidae. It is gregarious and was, even is now, much hunted in the Faeroe Islands. Its sheep-like habits (embodied in one scientific name *deductor*) enable it to be easily driven on shore in herds, which are then harpooned. The foetus of this Whale has a few hairs; the number of phalanges in the two middle digits is very great, as many as eleven to fourteen. *G. scammoni*, *G. brachypterus*, and *G. indicus* are other reputed species of the genus allowed by True and Blanford

Grampus is a genus allied to the last. It has no teeth in the upper jaw, and but three to seven in the lower jaw, near the symphysis of the mandible. The pterygoids are in contact. There is no beak, and the pectoral fin is long. There are twelve pairs of ribs, of which six are two-headed. Apparently there is but one species, *G. griseus*, known as "Risso's Dolphin." It is a Mediterranean and Atlantic form, and is not common.

The genus *Orca* has as characters:—Teeth ten to thirteen, long and strong. Pterygoids not quite meeting. Vertebrae C 7, D 11 to 12, L 10, Ca 23. The first two or three fused. The dorsal fin is long and pointed.

Of this genus there may be more than one species; but the best known is the Killer Whale, *O. gladiator* (Fig. 180, p. 341), often spoken of as the "Grampus."[2] It is marked with contrasting bands of white or yellow upon a black body-colour. The animal grows to a considerable length, as much as 30 feet. *Orca* is a powerful and rapacious Whale; and Eschricht has stated that from the stomach of one, thirteen Porpoises and fourteen Seals were extracted. They will also combine to attack larger Whales, and Scammon has related how he witnessed such an onslaught upon a Californian

[1] See an essay on the hunting of this Whale, by S. H. C. Müller, in ***Fish and Fisheries***, Edinburgh (Blackwood), 1883.

[2] Grampus being a contraction of *grand poisson* is an obvious name to apply to any Whale.

Grey Whale. "Belua truculenta dentibus," observed Olaus Magnus of this Cetacean. The high dorsal fin has been much exaggerated in old drawings; it has been even represented as strong and sharpened at the end, so as to be capable of ripping open the belly of a Whale. The fact that it sometimes lies over a little to one side is responsible for another anecdote: that an example of this Whale was seen to retire with a couple of Seals tucked away under the flippers, another grasped by the dorsal fin, and a fourth in the mouth! "When an Orca pursues a whale," wrote Dr. Frangius, "the latter makes a terrible bellowing like a bull when bitten by a dog." It is probable, according to F. Cuvier, that this Whale is the "Aries marinus" of the ancients, certain bands of white upon the head giving an impression of curved horns. It may also be the "horrible Sea-satyre" of Edmund Spencer.

Allied to *Orca*, but distinguishable from it by some rather minute peculiarities, is *Pseudorca*. It may be thus defined:—Teeth eight to ten, much like those of *Orca*. Dorsal fin rather small, falcate. Vertebral formula C 7, D 10, L 9, Ca 24. Six or all the cervicals united. The curious fact about this Whale, which embraces only a single species, *P. crassidens*, is that it was first known in the fossil condition from remains discovered in the fens of Lincolnshire. An important day for cetologists was that on which a whole herd entered the Baltic and furnished material for a better study of this Whale. It is not, any more than its near ally *Orca*, confined to northern seas; for several examples, at first relegated to a distinct species (*P. meridionalis*), have been obtained from the seas round Tasmania.

Orcella (which has been written *Orcaella*) has fourteen to nineteen small sharp teeth in each half of each jaw. The pterygoids are widely separate. The dorsal fin is small and falcate. The vertebral formula is C 7, D 14, L 14, Ca 26. Seven ribs are two-headed, and five of them reach the sternum.

This genus contains but a single species, *O. brevirostris*, which is both marine and fresh-water in habit; it occurs in the Indian seas, and in the Irrawaddy even as far up as 900 miles from the sea. Some regard the fresh-water individuals as a distinct form, *O. fluminalis*.

Sagmatias is a genus known only from a skull, which is remarkable for the elevation of the premaxillae into a crest; the

pterygoids are short, and there are thirty-two teeth in each half of each jaw.

Feresia is known from two skulls which are provided with ten to twelve teeth in each half of each jaw. It is intermediate between *Globicephalus*, *Grampus*, and *Lagenorhynchus*, according to Sir W. Flower.

The genus *Delphinus* contains the Dolphin, *D. delphis*.[1] The genus may be characterised as follows:—Teeth small and numerous, forty-seven to sixty-five. Vertebral formula C 7, D 14 or 15, L 21 or 22, Ca 30 to 32. The atlas and axis are fused, the rest free. The palatal border of the maxillae is deeply grooved. The fins are falcate; the beak long and distinct.

The Common Dolphin of the Mediterranean shows so many variations of colour, slight differences in the proportions of the bones of the skull, and in the number of the teeth, that it has been divided up into at least seventeen "species." But M. Fischer, who has studied many of these forms, does not admit them, and most students of this group of mammals follow him in the matter. The Dolphin is and has been the most familiar of Cetaceans: in consequence it has accumulated much anecdote of a mythical character. The extreme intelligence and goodwill towards man assigned to this creature by the ancients are possibly due to the anomaly of a creature ostensibly a fish showing many of the characters of higher animals. Its unfishlike intelligence baffled the early observers, who at once endowed it with especially advanced attributes. Hence the stories of Arion and others. The leaping of the Dolphin out of the water is exemplified in many Mediterranean coins and coats of arms; the heraldic dolphin is represented with an arched back as in leaping. The Dolphin reaches a length of some 7 feet, and appears to be world-wide in range. Possibly distinct is *D. longirostris*, characterised, as the name denotes, by the very long beak; it has also more teeth and is a native of Malabar. *D. roseiventris* again may be a third species of *Delphinus*. It comes from Torres Straits, and has the under parts rosy in colour.

The genus *Prodelphinus* has, like *Delphinus*, a distinct beak; but it has not the grooved maxillaries. No other character of importance appears to separate it from *Delphinus*.

[1] See *Actes Soc. Linn. Bordeaux*, 1881; and for another figure, also coloured, Flower, in *Trans. Zool. Soc.* xi. 1880, pl. i.

The genus consists of some eight widely distributed species, which are none of them large Dolphins.

Lagenorhynchus has the following assemblage of characters:—Head with short, not very distinct beak. Dorsal and pectoral fins falcate. Teeth small, twenty-two to forty-five in each half jaw. Vertebrae ranging in number from seventy-three to ninety-two. Pterygoid bones either in contact or separate. There are fifteen or sixteen pairs of ribs, of which six are two-headed. Of this genus Mr. True allows eight species, which have been increased by a ninth since the publication of his "Revision."[1]

Two species of *Lagenorhynchus* are known from our coasts; the rest are mainly southern in range. The British species are, firstly, *L. albirostris*, a Dolphin of some 9 feet in length. It has a large number of vertebrae, ninety-two in number. *L. albirostris* is a rare species, the first record of its occurrence on these shores being in 1834. Since that date some eighteen individuals have been shot or stranded on the shores of the British Isles. The second British species, *L. acutus*, differs in colour from the first. As in the last, the upper parts are black and the under parts white; but in *L. acutus* there is also a stripe on the flanks, brownish in colour. It has fewer vertebrae, not more than eighty-two.

The next genus of Dolphins, *Sotalia*, is characterised by—Teeth tolerably large, twenty-six to thirty-five. The vertebral formula is C 7, D 11 or 12, L 10 to 14, Ca 22. The pterygoids are not in contact in the middle line. It has a distinct beak.

Of this genus there are some six species (the exact number, as in so many other genera, cannot be positively asserted), most of which are fluviatile or estuarine in habit. They are also on the whole characterised by their pale, if not actually white, coloration. *S. sinensis* of the Amoy is white with pinkish fins. *Sotalia guianensis* is American as its name denotes. It is figured by van Beneden as of a pale brown colour. It is very abundant in the Bay of Rio de Janeiro, and has the reputation of being a friend of man like some other Dolphins. The natives hold that it will bring to shore the bodies of drowned persons. The most singular species of the genus is that recently described by Professor Kükenthal as *S. teüszii*.[2] This animal is purely fresh-water, being found in

[1] *Bull. U.S. Nat. Mus.* No. 36, 1889.

[2] *Zool. Jahrb. Syst. Theil*, vi. 1892, p. 442.

the Camaroon river, where it is extremely rare. The nostrils (blow-hole) are prolonged into a snout-like process, a fact which is of interest in connexion with the assertion that in *Balaenoptera* the blow-hole is puffed out during spouting. What is temporary in the Rorqual appears to be permanent in the *Sotalia*. More remarkable still, perhaps, is the assertion that it is a vegetable-feeding Dolphin. This is not a mere assertion except that it may not apply universally; for in the stomach of a specimen nothing but vegetable débris was found. But in the stomachs of other Whales (e.g. *Rhachianectes*) vegetable matter has also been found, which may perhaps have been taken in accidentally with the food.

Steno comes near *Sotalia*, and Dr. Blanford has transferred to it (under the one name of *Steno perniger*) the two species, *Sotalia gadamu* and *Sotalia lentiginosa*. It is, however, to be distinguished from *Sotalia* by the following characters:—Teeth large and few, twenty to twenty-seven on each side of each jaw, with furrowed surfaces to crowns. Vertebrae C 7, D 12 or 13, L 15, Ca 30 to 32. Pterygoids in contact. There are but two species apparently (not counting Dr. Blanford's).

Tursiops is not a very easily definable genus. These are its chief features:—Teeth large, twenty-two to twenty-six in number in each half of each jaw. Vertebral formula C 7, D 12 or 13, L 16 or 17, Ca 27. Pterygoids in contact. Beak distinct. Some five species are allowed; but it seems to be difficult to differentiate the others from *Tursiops tursio*. This, the best-known form, is quite or nearly world-wide in range, and occurs, though not abundantly, on our own coasts. Mr. True has observed that the eyelids of this Whale, which is largely hunted on the American coast, are as mobile as those of a terrestrial mammal. The name "tursio" is derived from Pliny. Belon would also derive from this word the French vernacular "marsouin." The latter term is sometimes regarded as a corruption of "Meerschwein," but it would seem to be more probably derivable from "marinum suem," from the Latin direct. *T. tursio* has the back black to lead-colour; the under parts white. In the reputed species, *T. abusalam*, from the Red Sea, the back is a dark sea-green. *T. tursio* reaches a length of 12 feet, but is more usually smaller.

The genus *Tursio* must be carefully distinguished from

Tursiops. It has no dorsal fin, the teeth are small and numerous (forty-four), and the pterygoids are separate. There are two species, *T. borealis* and *T. peronii*, the former being northern and the latter more widely spread.

The genus *Cephalorhynchus* has for its chief characters the following:—Teeth twenty-five to thirty-one, small and sharp. Pterygoids widely separated. Dorsal fin not falcate, but triangular or ovate in form. Beak not well marked off from the head. The species of this genus are all southern in range; four are perhaps to be allowed.

Fam. 3. Platanistidae.—This family of Odontocetes may be distinguished from the Dolphins by the following assemblage of structural features:—Cervical vertebrae all free, and each one of some length (for a Cetacean). Jaws long and narrow, with a considerable length of symphysis. Teeth very numerous.

This very meagre series of differential characters is largely due to *Pontoporia* on the Platanistid side, and to *Monodon* and *Delphinapterus* upon the Delphinid side. Otherwise the family Platanistidae would be extremely distinct. The two last-named genera have separate cervical vertebrae, and in the Beluga at any rate this is expressed externally by a quite distinct neck. Moreover, as Mr. True has pointed out, the pterygoid bones have not the involuted cavity below which characterises other Dolphins; and they have, what other Dolphins have not, an articulation outwards with the roofing bones of the skull. Sir W. Flower described the fact that in *Inia* (and the same occurs in *Pontoporia*) the palatines are separated from each other by the intervention of the vomer. In this feature they resemble certain Ziphioids, *Berardius*, *Oulodon* (= *Mesoplodon*) *grayi*, and *Hyperoodon*. The true Dolphins also appear to show the same intervention of the vomer in a few cases. There is nothing, therefore, distinctive from the Delphinidae in this feature.

The existence of cartilaginous sternal ribs in *Inia* and *Platanista* shows affinity between these two genera and the Physeteridae. *Pontoporia* is Dolphin-like in this particular, as it is also in the mode of articulation of the ribs with the vertebral column. But this last matter has already been dealt with. The principal reason for placing *Pontoporia* with the other two genera is the close resemblance which its skull bears to that of *Inia*.

The first genus of this family which will be noticed is *Platanista*.

The following are its main characters :—Dorsal fin absent. Eyes rudimentary. Pectoral fins large and truncated at the extremity. Teeth, about twenty-nine in each half of each jaw. Scapula with the acromion coinciding with its anterior edge. Skull with enormous maxillary crests, and with the palatines entirely concealed by the pterygoids. The length of the above definition will serve to indicate how anomalous in many particulars is the structure of this "Dolphin."

There is apparently but one species, *P. gangetica*, the "Susu." The Indian vernacular name is derived from the sound that the animal makes when spouting. It is an inhabitant of the Ganges and the Indus, together with their tributaries, and ascends very high up its streams. It is also thought to be purely fluviatile and never to desert the rivers for the sea. *Platanista* lives chiefly by grubbing in the mud for prawns and fish. Grains of rice have also been found in the stomach, but this would seem to be accidental. The long snout of the Susu has been compared to the long snout of the Gharial, a native of the same region. This Whale grows to a length of over 9 feet, but this length is exceptional. Its anatomy has been elaborately described by Dr. Anderson.[1]

The next genus, *Inia*, is thus to be characterised :—Dorsal fin rudimentary, pectorals large and ovate. Teeth, as many as thirty-two on each side, often with an additional tubercle. Skull without large maxillary crests; palatines not hidden by pterygoids, but divided by vomer. The vertebrae of this genus are few in number, only forty-one in all, which are thus distributed: C 7, D 13, L 3, Ca 18. The peculiarities of the vertebral column are several. In the first place, as has been mentioned in the definition of the family, all the cervicals are separate and individually of some length. Secondly, the axis has a better trace of an odontoid process than in any other Whale except *Platanista*, where it is even more obvious. The lumbar region is remarkable on account of its restriction to three vertebrae. The sternum, by what we must regard as convergence, is somewhat like that of the Whalebone whales. It consists of one piece only, of a roughly-oval form, to which apparently only two pairs of (cartilaginous) sternal ribs are attached. In the fore-limb the proportions between the humerus and the radius are more like

[1] *Anatomical Researches Yunnan Exp.* 1878, p. 417.

those of terrestrial mammals; *i.e.* the humerus is distinctly the longer, the converse usually obtaining among Whales. But *Platanista* again agrees with *Inia*. The teeth are remarkable for the fact that the hindermost ones of the series have an additional lobe; they are not purely conical as are those of Whales generally.

There is but one species, *Inia geoffrensis*, which inhabits the Amazons, and grows to a length of 8 feet. Its colour variations are rather extraordinary, unless they can be set down to sex, which has been denied. Some individuals are wholly pink; others are black above and pink beneath. This Whale is believed by the Indians to attack a man in the water, and it is added that the *Sotalia* of the same streams will defend him from these attacks! Naturally, therefore, superstitious reverence attaches to this Dolphin, which is tiresome to the naturalist who wants specimens, as Professor Louis Agassiz found.

In the genus *Pontoporia* [1] the dorsal fin is well developed and falcate. The teeth are very numerous, 200 in all. The ribs articulate as in Dolphins. The skull closely resembles that of *Inia*, and the scapula is, as in that genus, "normal."

The proper name for *Pontoporia* is really *Stenodelphis*, which name was first used by Gervais a month or two before Gray, who separated it from the vague *Delphinus* of its original discoverer, Gervais himself. It has a longer snout than *Inia*, which, being bent towards the extremity in a downward direction, curiously suggests the skull of a Curlew. In details, however, the skull is exceedingly like that of *Inia*. It is nearly symmetrical. The vertebral formula appears to be the following:—C 7, D 10, L 5, Ca 20 = 42, just one over the number of the vertebrae in *Inia*. The sternum is in two pieces. Of the ten pairs of ribs the first three are double-headed. These and the next have sternal moieties joining the sternum, of which the first three are ossified, the last being apparently merely a ligament.

There is a single species of the genus, *P. blainvillii*. This Whale is described by Mr. Lydekker as being of a clear brown colour, harmonising with the waters of the estuary of the Amazons and the La Plata which it inhabits. The same colour characterises *Sotalia pallida* of those parts of the world, and

[1] Flower, *Trans. Zool. Soc.* vi. 1867, p. 106; and Burmeister, *Proc. Zool. Soc.* 1867, p. 484.

may be a colour adaptation. But the extant accounts of the colour of this Dolphin vary—quite possibly in accordance with real variations, such as are exhibited by *Inia* already spoken of. *Pontoporia blainvillii* is a smallish Dolphin some 4 feet in length.

Fossil Odontocetes.—Several of the existing genera of Dolphins are also known in a fossil condition, as well as Ziphioid Whales closely related to existing forms. We shall deal here only with a few genera of fossil Odontocetes which depart in their structure from existing forms.

The genus *Physodon* is Miocene, and has been found in Patagonia. It appears to be most nearly allied to the Physeteridae, but should probably form a distinct family. *Physodon* was not so large as *Physeter*, the skull measuring only some 10 feet. It thus comes nearer in point of size to *Kogia*, and it is interesting to note that its relatively-shorter snout is also suggestive of the dwarf Cachalot. The general outline of the skull is, however, more like that of *Physeter*, and there is the same deep cavity for the lodgment of spermaceti. The main feature of interest in the skull is the presence of teeth in both jaws, and the fact that two or three are lodged in the premaxillae. This is precisely what is found in the most ancient Whales, the Zeuglodonts.

Extinct Dolphins, apparently referable to the Platanistidae, are the most numerous among the earlier forms of Cetaceans, and it is significant that the earliest known forms of these go back to the Eocene.

The genus *Iniopsis* of Mr. Lydekker,[1] with one species, *I. caucasica*, comes from rocks which seem to be of that age. The back part of the skull of this animal, the only part of the skull known, has the same squarish excavation of the maxillaries that characterises *Inia* and *Pontoporia*. Its lower jaw was slender and possessed numerous teeth.

The long snout and jaws of Platanistids, especially exaggerated in *Pontoporia* among living forms, are constantly found in these Tertiary Platanistids.

Eurhinodelphis had a beak three and a half times the length of the cranium, whereas in *Pontoporia* the proportions are as 2 : 1. The teeth too were very numerous.

The genus *Argyrocetus*, from Patagonian Tertiary strata, was an animal about as large as the existing Dolphin. It had the

[1] *Proc. Zool. Soc.* 1892, p. 558.

slender rostrum and numerous teeth of the Platanistids and the squared excavations of the maxillaries. *Argyrocetus patagonicus* possessed also archaic characters, suggesting earlier affinities still. The two condyles of the skull instead of being closely adpressed to the skull stood out in a way more like that met with in terrestrial mammals. The nasal bones instead of being abbreviated rudiments are well developed as in the archaic Zeuglodonts. The cervical vertebrae of this Whale are all perfectly free from each other and individually long. The skull is on the whole bilaterally symmetrical; this again is a feature more pronounced among the Platanistidae than among other Odontocetes. Accompanying these generalised Cetacean characters are some which show that the animal was too specialised to be the direct ancestor of any existing forms. The end of the mandible was upturned and without teeth, its form being quite unique among Cetacea. Other allied forms, such as *Zarrhachis* and *Priscodelphinus*, showed the same length of the cervical vertebrae.

A very distinct family of extinct Whales is that of the **Squalodontidae**. They to some extent bridge over the gap between the existing Odontoceti and the Eocene Archaeoceti (Zeuglodonts).

The skull of these Whales was on the whole Dolphin-like. But they possessed teeth which were distinctly specialised into incisors, canines, and molars. The molars have a coarsely-serrated cutting edge as in the Zeuglodonts, and are also to some extent two-rooted. But they are more numerous, and so far approximate to the conditions which characterise the more typical modern Odontocetes. *Squalodon* was a long-beaked form, and *Prosqualodon* had a skull whose proportions are nearer those of *Kogia*.

SUB-ORDER 3. ARCHAEOCETI.

This division of the Whale tribe embraces but a single family, **Zeuglodontidae**, of which but a single genus, *Zeuglodon*, can with certainty be discriminated.

Zeuglodon is an Eocene form of large size, with teeth which are limited in number and disposed in three series as incisors, canines, and molars. The molars are double-rooted, a fact which has given to the genus its name. The nasal bones being long

instead of rudimentary like those of other Whales, the blow-hole lies more in the middle of the face. The skull, too, is not Whale-like in a number of other points. Thus the pre-maxillaries take their fair share in the outline of the upper jaw; and, furthermore, bear the incisor teeth. The parietals meet above in a crest and are not excluded from the roof of the skull. The vertebrae of the neck are in no way shortened; neither are they fused together. The ribs are double-headed, and the sternum is made up of several pieces. Some naturalists, particularly Professor D'Arcy Thompson,[1] have assigned a relationship to the Seals to these ancient Cetacea; but others[2] have disputed this view chiefly on the grounds that the characters which appear to be Seal-like are simply characters which are generalised and so far at most not Whale-like. Thus the long neck and the serrated character of the teeth may be accepted as Seal-like on the one hand; but on the other, a simple serrated tooth and a long neck are not by any means features of organisation which we should consider out of the way in an ancient form of Cetacean which probably preyed upon fish. The humerus of *Zeuglodon*, according to Mr. Lydekker, puts out of court any possible near relationship to the Seals. But the matter under dispute can be further studied by reference to the three memoirs quoted below.

[1] Thompson, *Studies Mus. Dundee*, i. 1890; and *C. R. Congrès de Zoologie*, 1889, p. 225.

[2] Lydekker, *Proc. Zool. Soc.* 1892, p. 560.

CHAPTER XIII

CARNIVORA[1]—FISSIPEDIA

Order VII. CARNIVORA

THIS order may be thus defined:—Small to large quadrupeds, terrestrial, arboreal, or aquatic, of usually carnivorous habits. The teeth have generally sharp and cutting edges, and the canines are well developed; the incisors are small, and four to six in number. The number of toes is never less than four. There are usually strong and sharp claws. The clavicles are incomplete or absent. In the hand the scaphoid and lunar bones are always united. The brain is well developed, and the hemispheres are well convoluted. The stomach is always simple, while the caecum, if present, is always small. The members of this group have a deciduate and zonary placenta.

The fewness of the characters used in the above definition is chiefly owing to the fact that the Seals and Sea-lions, although they are referable without a doubt to this order, have undergone in their metamorphosis into aquatic animals so many changes that some of the main features in the structure of their terrestrial relatives have been lost. This group will, however, be again characterised. We shall deal at present with the land division of the Carnivora, the CARNIVORA FISSIPEDIA as they are generally termed. The name is of course given to them to distinguish them from the corresponding division of the PINNIPEDIA. In the latter group the feet and hands are modified into "fins"; in the other the fingers and toes are cleft, as with terrestrial beasts generally.

[1] For a general account of the osteology, see Flower, *Proc. Zool. Soc.* 1869, p. 4; and for muscular anatomy, Windle and Parsons, *Proc. Zool. Soc.* 1897, p. 370, and 1898, p. 152.

SUB-ORDER 1. FISSIPEDIA.

A very marked feature of the terrestrial Carnivora is to be found in the structure of the teeth. The incisors are nearly always six, and are somewhat feebly developed in many cases. The

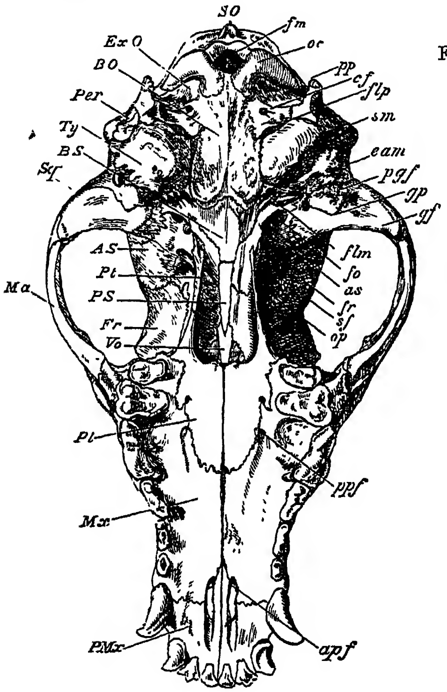

FIG. 190.—Under surface of the cranium of a Dog. ×½. *apf*, Anterior palatine foramen, *AS*, alisphenoid; *as*, posterior opening of alisphenoid canal; *BO*, basioccipital, *BS*, basisphenoid; *cf*, condylar foramen; *eam*, external auditory meatus; *ExO*, exoccipital; *flm*, *flp*, foramen lacerum medium and posterius; *fm*, foramen magnum; *fo*, foramen ovale; *Fr*, frontal; *fr*, foramen rotundum; *gf*, glenoid fossa; *gp*, post-glenoid process; *Ma*, malar; *Mx*, maxilla; *oc*, occipital condyle; *op*, optic foramen; *Per*, mastoid portion of periotic; *pgf*, post-glenoid foramen; *Pl*, palatine; *PMx*, premaxilla; *pp*, paroccipital process; *ppf*, posterior palatine foramen; *PS*, presphenoid; *Pt*, pterygoid; *sf*, sphenoidal fissure or foramen lacerum anterius; *sm*, stylomastoid foramen; *SO*, supraoccipital; *Sq*, zygomatic process of squamosal; *Ty*, tympanic bulla, *Vo*, vomer. (From Flower's *Osteology*.)

canines are almost invariably very large strong teeth, and are always present. In some of the extinct Cats they reached enormous dimensions. The number of cheek teeth is not always identical; but the last premolar in the upper jaw and the first true molar in the lower jaw, known as the "carnassial" or "sectorial" teeth, mark a difference in structure between the anterior and the posterior crushing teeth; those in front of the carnassial tooth have cutting edges, and are often merely small, conical teeth; those behind have broader crowns and are tuberculate; those of simpler forms often trituberculate; those of others

with numerous tubercles. The carnassial tooth is often, but by no means always, very much larger and especially longer than the rest of the molar and premolar series. It is less pronounced in some of the omnivorous Arctoidea. The skull of the Carnivora is longer in the more primitive types, such as the Canidae, and shorter in the more specialised Felidae. The orbit is hardly ever completely shut off by bone, though the postorbital process of the frontal sometimes approaches the corresponding upward process of the zygomatic arch. The palate, which is completely ossified, sometimes reaches back for some distance behind the teeth; it always extends as far as the last molar. The tympanic bulla is often very inflated, and if flatter, as in the Bears, is at any rate large and conspicuous. The lower jaw has

A B

FIG. 191.—A, Atlas of Dog. Ventral view. × ½. B, Axis of Dog. Side view. × ⅔. *o*, Odontoid process; *pz*, posterior zygapophysis; *s*, spinous process; *sn*, foramen for first spinal nerve; *t*, transverse process; *v*, vertebrarterial canal. (From Flower's *Osteology*.)

a high coronoid process, and the condyle is transversely elongated, this part of the bone being rolled into an almost cylindrical form; it fits very closely into the glenoid cavity, and the articulation is thereby very strict—an obvious advantage in a creature with so great a need for power of jaw.

In the vertebral column the atlas always has large wing-like processes; the spine of the axis vertebra has a long antero-posteriorly elongated form. The transverse processes of the fourth to the sixth cervicals are, as a rule, double. These features, however, though characteristic of the Carnivora are not by any means distinctive. The true sacrum consists of but a single vertebra to which the ilia are attached; but at most two other vertebrae are fused with this. The clavicle is always small and sometimes quite rudimentary, or even absent. The spine of the scapula is well developed, and almost equally divides the

surface of that bone. The digits of the Carnivora are mostly five, and are never less than four. The mode of progression may be digitigrade or plantigrade, and the intermediate semidigitigrade

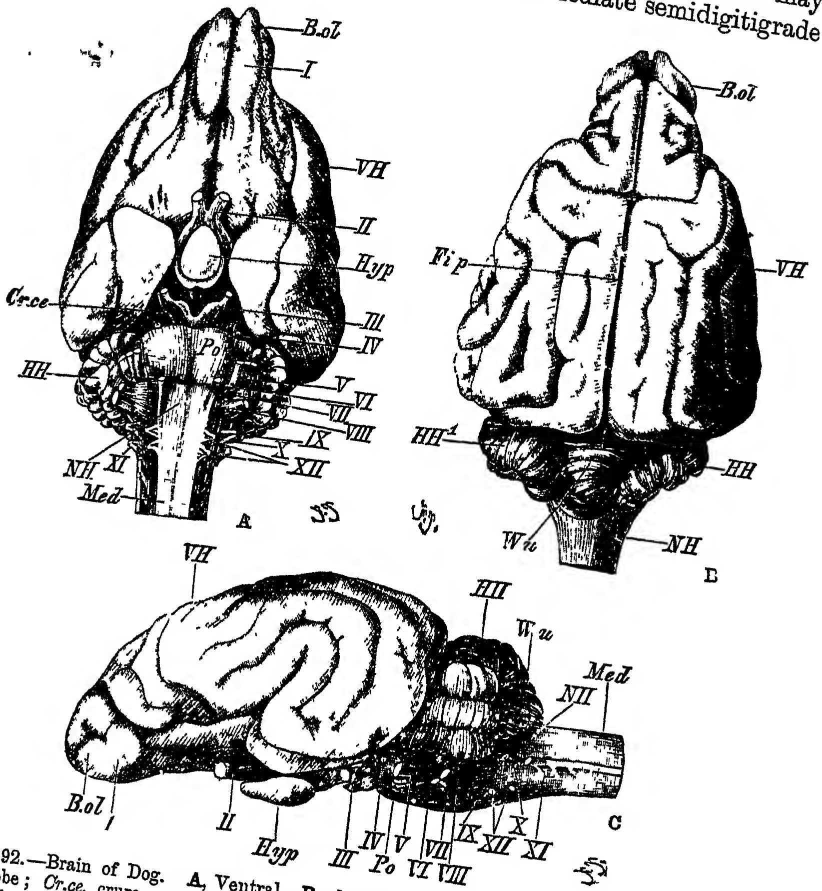

FIG. 192.—Brain of Dog. **A**, Ventral, **B**, dorsal; **C**, lateral aspect. *B.ol*, Olfactory lobe; *Cr.ce*, crura cerebri; *Fi.p*, great longitudinal fissure; *HH*, *HH*[1], lateral lobes of cerebellum; *Hyp*, hypophysis; *Med*, spinal cord; *NH*, medulla oblongata; *Po*, pons Varolii; *VH*, cerebral hemispheres; *Wu*, middle lobe (vermis) of cerebellum; *I-XII*, cerebral nerves. (From Wiedersheim's *Comparative Anatomy*.)

mode of walking also occurs. The brain in all Carnivora is large and well convoluted. The arrangement of the convolutions is characteristic. There are three or four gyri disposed round each other, of which the lowest surrounds the Sylvian fissure. The stomach in these creatures is always simple in form, without

subdivisions. The caecum is never large, and may be, as in the Bear tribe, completely absent.

The distribution of the Carnivora is world-wide, excluding only the Australian region, if, as seems probable, the Dingo of that region is an introduced species. The most striking features in their distribution are perhaps the following:—There are no Bears in the Ethiopian region or in Madagascar, and but a single species in the Neotropical. The only Carnivora in Madagascar are the Viverridae, and of the seven genera there found six are peculiar. The Procyonidae are nearly entirely New World in range; out of sixteen genera of Mustelidae only five are New World, and only two of those are peculiar to the American continent. The Hyaenidae are limited to the Old World.

The classification of the Carnivora is a matter which is difficult, and which has therefore been very variously effected. It is unfortunate that the classification of Flower (based upon the researches of H N. Turner as well as his own, and accepted by Mivart) should fail when applied to fossil forms. For it separates with great clearness the existing genera into three great divisions, the Cynoidea, Aeluroidea, and Arctoidea, definable by visceral as well as by osteological characters. The apparent anomaly, too, of a single supposed Viverrine genus, to wit *Bassariscus*, existing in America, while all the rest of its kin are Old-World forms, was shown by his characters to be neither an anomaly nor a fact. It will be better, therefore, to divide the Carnivora into the families, Felidae, Machaerodontidae, Viverridae, Hyaenidae, Canidae, Ursidae, Procyonidae, and Mustelidae, indicating at the same time the reasons for and against retaining the three divisions of Sir W. Flower.

Fam. 1. Felidae.[1]—This family includes only the Cats (*i.e.* Lions, Tigers, "Cats," Hunting Leopard, etc.), and is to be distinguished by the following characters:—In the skull the auditory bulla is much inflated, and there is an internal septum; the paroccipital processes are flattened against the bullae. There is no alisphenoidal canal. The dental formula is I 3, C 1, Pm 3 to 2, M 1. The carnassial tooth of the upper jaw has three lobes to the blade; that of the lower jaw is without an inner cusp.

[1] See St. G. Mivart "On the Aeluroidea," *Proc. Zool. Soc.* 1882, p. 135: and *The Cat*, London, J. Murray, 1881.

The digits are five on the fore-feet, four on the hind. The caecum is present and small. This family contains but two genera, *Felis* and *Cynaelurus*.

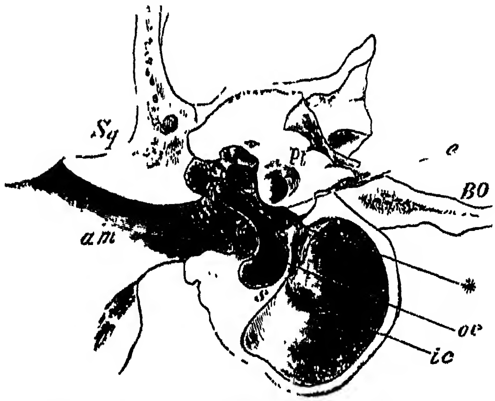

FIG. 193.—Section of auditory bulla of Tiger. *am*, Auditory meatus; *BO*, basioccipital; *e*, Eustachian canal; *ic*, *oc*, two chambers of bulla divided by *s*, septum; *, their aperture of communication; *Pt*, periotic; *Sq*, squamosal; *t*, tympanic ring. (From Flower's *Osteology*.)

The genus *Felis* is very wide in its distribution, being common to both the Old and the New Worlds. Its distinctive characters, as opposed to *Cynaelurus*, are mainly the following:—The claws are retractile, and the retractility is more markedly developed than in the Cheetah. The molar is not so nearly in a line with the other teeth; the upper carnassial, moreover, has an inner tubercle. The legs are relatively shorter.

FIG. 194. The phalanges of the middle digit of the manus of the Lion (*Felis leo*). × ½. *a*, The central portion forming the internal support to the horny claw; *b*, the bony lamina reflected around the base of the claw; *ph*¹, proximal phalanx; *ph*², middle phalanx; *ph*³, ungual phalanx. (From Flower's *Osteology*.)

The complete retractility of the claws is a very distinctive feature of the true Cats. It is brought about in this way: the terminal joint of the toe, which is clad with the claw, folds back into a sheath by the outer side of or above the middle phalanx. It is held in this position by a strong ligament. The flexor muscles straighten the phalanx which bears the claw, so that the natural position for the animal is to be in a state of retracted claws, which of course preserves them from friction; when wanted for aggressive purposes, they are pulled into sight by the action of the muscles already mentioned.

Much has been written as to the shape of the pupil of the Cat's eye. Some careful observations upon the matter have been

made by Dr. Lindsay Johnson,[1] who found that out of 180 Domestic Cats 111 had round pupils, and that in 19 the shape was a pointed oval, intermediate conditions being offered by the rest. These 180 comprised males and females of many varieties. When the pupil of the Cat's eye contracts, it forms a vertical slit with two pin holes, one at each end, through which alone light appears to enter. In the Genet and the Civet the contraction of the pupil is as in the Cat. In the Lion, Tiger—in fact apparently in all the large Cats—the pupil retains its circular shape even when contraction is fully effected. Dr. Johnson has, furthermore,[2] made some interesting experiments upon the Seal's eye—a creature which has, of course, to exert its powers of vision in two media, and from one to the other. This is effected by dilatation of the pupil when in the water, and its contraction to a vertical slit with parallel margins and rounded ends when in the air, the contraction being to some extent at least under the influence of the animal's will.

The coloration of these creatures is very varied: spots of black, or bordered with black upon a more or less tawny ground-colour, is the prevailing pattern. Stripes are also met with, as in the Tiger, but these are usually cross stripes,[3] while in the related Viverridae there are many examples of longitudinal stripes. Finally, many Cats, as for instance the Puma and the Eyra, are "self-coloured"—have, that is to say, a uniform tint. Just as the unstriped Horse sometimes shows traces of the former existence of stripes, so the self-coloured Cats are occasionally spotted when young; this is markedly so in the case of the Puma; while the Lion is spotted as a cub, and in the adult—particularly in the lioness—there are distinct indications of these spots. It is evident, therefore, that there are grounds for regarding a spotted condition to be antecedent, at least in some cases, to a uniform colour. There are divers explanations of these hues and of these changes. It is held by many that the coloration has a relation to the habits of the creature: the spotted Cats, it is pointed out, are largely arboreal; this is eminently so with the Jaguar at any rate; and in an arboreal

[1] "On the Pupils of the Felidae," *Proc. Zool. Soc.* 1894, p. 481.

[2] "Observations . . . on the Seal's Eye," *Proc. Zool. Soc.* 1893, p. 719.

[3] It is noteworthy that in the Tiger some of the stripes have pale centres and are thus like spots pulled out, while there are also small black spots.

creature the spots, it is said, give the impression of flecks of sunlight broken up by foliage. On the other hand, the self-coloured Cats of a sandy to earthen hue assimilate in tint with a sandy or stony soil. The stripes of the Tiger, it is thought, approximate to the tall parallel stems of grasses and other plants in the dense cover in which it lives. In favour of these views is undoubtedly the fact that in other mammals and other animals belonging to quite different groups the same four plans of coloration are met with. Spots and cross stripes are found in the Marsupials; the young Tapir is spotted while the adult is self-coloured, and so forth. This last fact, however, serves to illustrate another view which has been put forward in explanation of these characteristic markings of the Felidae. Eimer has come to the conclusion that there is and has been a regular series of steps in the evolution of these markings. The primitive condition was, he thinks, a longitudinally striped one; the stripes then broke up into spots, and the spots rearranged themselves as transverse stripes; the self-coloured Puma and Lion are a final stage in this gradual evolution. In support of this is the fact that spots precede self-coloration in the individual growth of these animals. The exact sequence of these markings is, however, contradicted by Dr. Haacke's observations upon a certain Australian fish which is cross striped when young and longitudinally striped when adult, a precise reversal of what ought to occur on Eimer's view.

The Felidae are almost universally distributed with the exception, of course, of Australia and a good deal of the Australian region; the headquarters of the group are undoubtedly in the tropics of the Old World.

The characteristics of a few species of the Cat tribe will now be given. As there are at any rate forty-five species, this survey will have to be somewhat incomplete.

The Lion, *F. leo*, differs from all other species by the mane of the male. It is an inhabitant of Africa, India, and certain parts of Western Asia. Within the historic period it ranged into Europe. According to Sir Samuel Baker those of us who have not seen the Lion in his native haunts have never seen a really magnificent specimen of the brute; but other travellers disagree, and state that a captive Lion is often a finer animal—by reason, of course, of good feeding. Unlike the majority of Cats, the Lion

cannot climb His roar (which is so suggestive, towards its end, of that animal who once dressed himself up in his skin) is literally *after* his prey. The Lion, it is stated, does not roar except upon a full stomach. The Lion is mainly nocturnal in its habits, and is said to be not in the least dangerous if unprovoked in the daytime; but here again opinions differ. The tail of the animal is provided at the extremity with a slight claw, but it can hardly be sufficient for the animal to lash itself into a fury with it. A Lion will live for thirty or forty years, and will breed freely in captivity. The Gardens of the Zoological Society of Dublin have been famed for their success in breeding Lions; but more surprising still, this has been successfully accomplished in travelling menageries. The "desert" colour of the Lion is familiar to all. It is stated that the likeness to the parched soil of certain parts of Africa is greatly heightened by black patches in the mane, for in certain regions of that continent the arid yellow of the general environment is diversified by pieces of black lava. It is apparently a popular delusion to speak of the Maneless Lion of Guzerat. No doubt maneless Lions do come from there, but so do young and maneless Lions from other places; in short, it is simply a question of age, and old Lions from the Asiatic continent are as fully maned as those from Africa.

The Tiger, *F. tigris*, is an animal of about the same size as the Lion, distinguished, of course, by the stripes. The skeletons are much like those of other Cats; but the skull of the Tiger may be distinguished from that of the Lion by the fact that the nasal bones reach back beyond the frontal processes of the maxillae. The Tiger is an exclusively Asiatic beast, ranging northward into icy Siberia. The northern individuals have a closer fur, and have been quite unnecessarily separated as a distinct variety. Nine feet six inches is the size of the average full-grown Tiger; but the skins will stretch, a fact of which the sportsman will sometimes take advantage. A "man-eater" is a Tiger which has discovered "that it is far easier to kill a native than to hunt for the scarce jungle game." As with the Lion, the accounts of travellers differ enormously, particularly with regard to the strength of the creature. Some have said that a Tiger can easily lift a full-grown bullock and leap with it in the mouth over a considerable obstacle, a statement which is ridiculed by Sir Samuel Baker. Unlike the Lion, the Tiger can climb trees;

it will also voluntarily enter the water, and can swim considerable rivers.

Mr. H. N. Ridley[1] observes that Tigers "habitually swim over to Singapore across the Johore Strait, usually by way of the intermediate islands of Pulau Ubin and Pulau Tekong. They make the passage at night, landing in the early morning. As so much of the coast is mangrove swamp, and the animals do not risk going through the mud, they are only able to cross where the shores are sandy, and thus they have regular starting- and landing-places."

The Tiger is mainly nocturnal, but begins its depredations towards five o'clock in the afternoon, before which it remains sleeping in shady thickets. If the weather is rainy and windy it becomes restless and wanders about earlier. Under the provocation of extreme hunger it will hunt during the daytime. Hunger, too, naturally produces extreme boldness. Mr. Ridley relates a story of four Tigers who walked up the steps of a house in search of the master of the house or his dog, and broke into it, the inhabitants retiring in their favour. The Malays have superstitions about Tigers, which are precisely paralleled by the man-and-wolf stories of Europe. "Certain people are supposed to have the power of turning into tigers for a short time, and resuming their human form at pleasure. The transformation commences tail first, and the human tiger is so completely changed that not only has it all the actions and appearance of the tiger, but on resuming its human form it is quite unconscious of what it has been doing in the tiger state." Mr. Ridley disputes the common stories as to man-eaters. If a Tiger has once tasted human flesh it does not always confine itself afterwards to that article of diet, nor is it only aged and comparatively toothless animals which hunt man. That they do take a large toll of coolies is an undoubted fact, and many are the artifices to prevent the rest from knowing the fate of one of their fellow-workmen, or of becoming acquainted with the presence in the neighbourhood of one of the dreaded beasts.

The Leopard or Panther, *F. pardus*, is, like the Lion, African and Asiatic in range. The animal is spotted with rosettes of black spots surrounding a central field of the tawny colour of the body generally. Some of the spots are solid and black. "The

[1] *Natural Science*, vi. 1895, p 89.

pantere like unto the smaragdyne" seems to be an inapt description of this Cat, unless indeed the eyes be referred to. The ancients ascribed to it a most fragrant odour. As with the Tiger, a northern variety of this Carnivore has a closer and longer fur. There is a tendency towards melanism in this animal, the black Leopard being comparatively common, particularly, it appears, in high lands. Several other variations in colour are known. These have received different specific names; but it seems that there is in reality but one species of Leopard. The Leopard can climb with the agility of any Cat. Sir S. Baker reserves the name Panther for large Leopards, which reach a length of 7 feet 6 inches. But there is no valid distinction between any two such varieties. The Leopard is as ferocious as the Tiger; and Sir Samuel Baker advises that the power of the human eye be not experimented with when meeting unarmed one of these brutes.

The Snow Leopard or Ounce, *F. uncia*, is a beautiful creature,

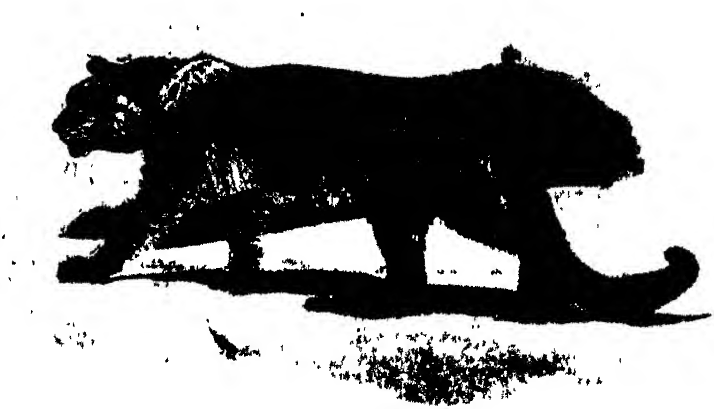

FIG. 195.—Snow Leopard *Felis uncia*. × $\frac{1}{20}$.

confined to the highlands of Central Asia. The ground-colour is white, and the spots are larger than those of the ordinary Leopard. Two examples of this rather rare Carnivore have been recently on view in the Zoological Society's Gardens, London. The Clouded Leopard, *F. nebulosa*, is an animal of considerable size (6 feet total length).

The Fishing Cat, *F. viverrina*, of India and China, is about 3 feet 6 inches including the tail. Its black spots upon a grey-brown ground have a tendency to form longitudinal lines. It is in fact, on Eimer's theory, a case of longitudinal stripes breaking up into spots. It differs from the bulk of Cats by preying upon fish, though it is not known how it catches them. It also feeds upon the large snail *Ampullaria*. In addition to these there are twenty-four species of Cats found in the Old World, mainly in the Oriental region, of small to moderate size.

The European Lynx, *F. lynx*, has rather long legs, a short tail,

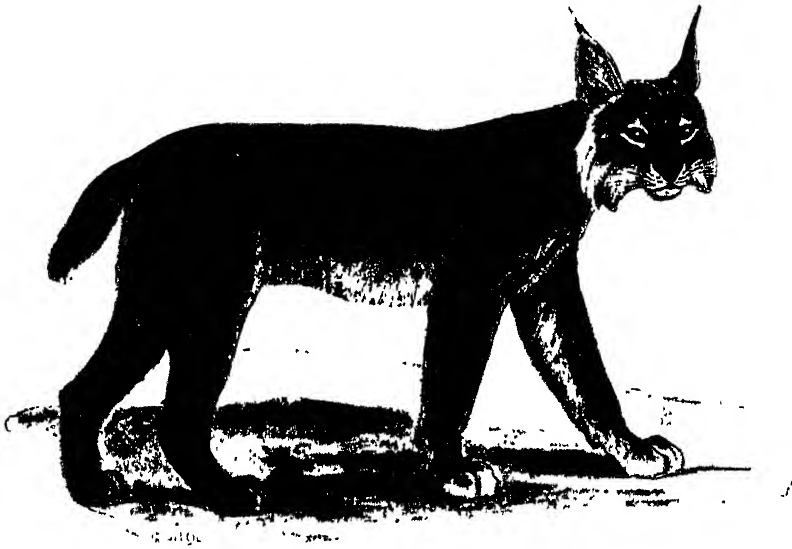

Fig. 196.—European Lynx. *Felis lynx* × $\frac{1}{12}$.

and tufted, pointed ears. It has only two premolars in the upper jaw instead of the usual three. It seems to be doubtful whether the Asiatic Lynx can be distinguished from the European, but the Spanish form, *F. pardina*, does appear to be distinct. The Common Lynx, sometimes called *F. canadensis*, also ranges into America, where some other forms exist, known by the specific names of *F. rufa* and *F. baileyi*.

In America there are altogether sixteen species of Cats, if we allow three species of Lynx, none of which, however, does Dr. Mivart allow to be different from the European and Asiatic Lynx (*F. lynx*).

The largest of American Cats is the Jaguar, *F. onca* This is an arboreal creature with a long, heavy body and short limbs. Its pelage is much like that of the Leopard, but the spots are larger and more definitely arranged in groups. There are a number of distinct rows of spots. The length of the body alone is not greater than 4 feet. They prey very largely on the

FIG. 197.—Jaguar. *Felis onca.* × 1/16.

Capybara, and upon turtles, which they surprise upon the sand when about to lay their eggs; the reptiles are turned upon their backs, so as to be incapable of escaping, and the Jaguar then easily devours them. The Jaguar will even pursue the turtle into the water, and will devour its eggs and the newly-hatched young.

The Ocelot is another spotted American Cat. *F. pardalis*[1] ranges from Arkansas in North America southwards, its range corresponding with that of the Jaguar. Although small for one of the "larger cats," the Ocelot inspired with considerable respect Captain Dampier, who remarked of it: "The Tigre-cat is about the bigness of a bull-dog, with short truss, body shaped much like a mastiff, but in all things else, its head, the colour of its hair, the manner of its preying, much resembling the

[1] For an account of this and of other mammals which occur in Central America, see Alston in Messrs. Godman and Salvin's *Biologia Centrali-Americana*, 1879-1882.

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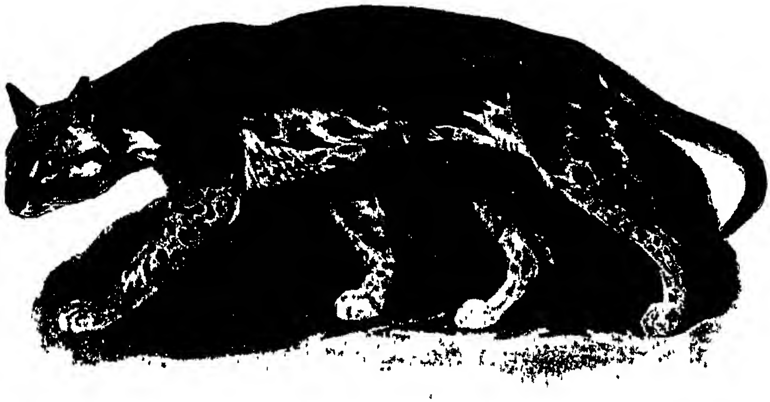

FIG. 198.—Ocelot. *Felis pardalis.* $\times \frac{1}{10}$.

The Puma, *F. concolor*, the American Lion as it is called in the north, is a rather smaller animal than the last, and of a uniform tawny colour, tending to white on the abdomen and to a dark stripe along the back. The young, as already mentioned, are very distinctly spotted. Like the Tiger, the Puma can endure extremes of heat and cold; it is equally at home in the snow of North America and among the tropical forests and swamps of the south. It is a ferocious creature so far as concerns Deer, Lamas, Raccoons, even Skunks and Rheas, but, according to Mr. W. H. Hudson, will not attack man, and will even defend him against the Jaguar.[1] In captivity the Puma will purr like a Cat.

The Eyra, *F. eyra*, is another self-coloured American cat, which has a curious likeness to the totally distinct *Cryptoprocta* of Madagascar.

The Wild Cat of Europe, *F. catus*, is found over the greater part of Europe, and also in Northern Asia. It was undoubtedly common at one time in this country, though it appears never to have extended its range into Ireland. But the real Wild Cat is now rare in this island, and is confined to certain districts in

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The Fishing Cat, *F. viverrina*, of India and China, is about 3 feet 6 inches including the tail. Its black spots upon a grey-brown ground have a tendency to form longitudinal lines. It is in fact, on Eimer's theory, a case of longitudinal stripes breaking up into spots. It differs from the bulk of Cats by preying upon fish, though it is not known how it catches them It also feeds upon the large snail *Ampullaria*. In addition to these there are twenty-four species of Cats found in the Old World, mainly in the Oriental region, of small to moderate size.

The European Lynx, *F. lynx*, has rather long legs, a short tail,

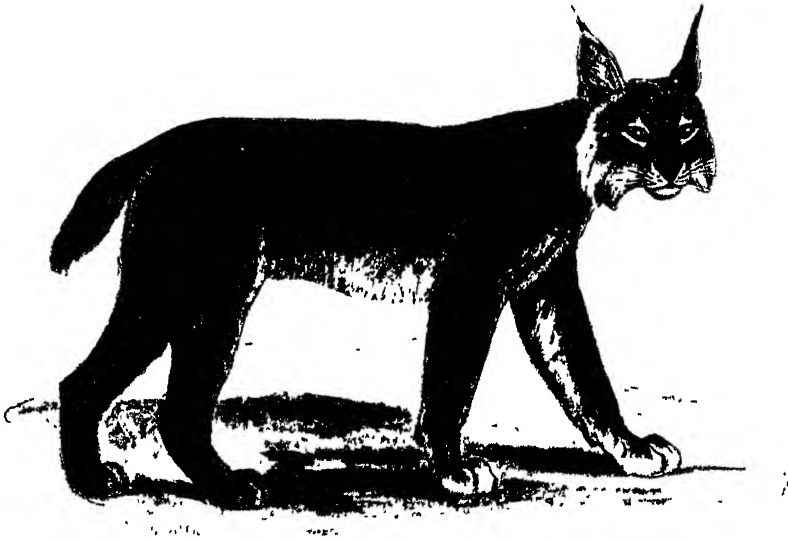


FIG. 196.—European Lynx. *Felis lynx* $\times \frac{1}{12}$.

and tufted, pointed ears. It has only two premolars in the upper jaw instead of the usual three. It seems to be doubtful whether the Asiatic Lynx can be distinguished from the European, but the Spanish form, *F. pardina*, does appear to be distinct. The Common Lynx, sometimes called *F. canadensis*, also ranges into America, where some other forms exist, known by the specific names of *F. rufa* and *F. baileyi*.

In America there are altogether sixteen species of Cats, if we allow three species of Lynx, none of which, however, does Dr. Mivart allow to be different from the European and Asiatic Lynx (*F. lynx*).

The largest of American Cats is the Jaguar, *F. onca.* This is an arboreal creature with a long, heavy body and short limbs. Its pelage is much like that of the Leopard, but the spots are larger and more definitely arranged in groups. There are a number of distinct rows of spots. The length of the body alone is not greater than 4 feet. They prey very largely on the

FIG. 197.—Jaguar. *Felis onca.* × 1/18.

Capybara, and upon turtles, which they surprise upon the sand when about to lay their eggs; the reptiles are turned upon their backs, so as to be incapable of escaping, and the Jaguar then easily devours them. The Jaguar will even pursue the turtle into the water, and will devour its eggs and the newly-hatched young.

The Ocelot is another spotted American Cat. *F. pardalis*[1] ranges from Arkansas in North America southwards, its range corresponding with that of the Jaguar. Although small for one of the "larger cats," the Ocelot inspired with considerable respect Captain Dampier, who remarked of it: "The Tigre-cat is about the bigness of a bull-dog, with short truss, body shaped much like a mastiff, but in all things else, its head, the colour of its hair, the manner of its preying, much resembling the

[1] For an account of this and of other mammals which occur in Central America, see Alston in Messrs Godman and Salvin's *Biologia Centrali-Americana*, 1879-1882.

tigre, only somewhat less. . . . But I have wisht them farther off when I have met them in the woods; because their aspect appears so very stately and fierce."

FIG. 198.—Ocelot. *Felis pardalis.* × $\frac{1}{10}$.

The Puma, *F. concolor*, the American Lion as it is called in the north, is a rather smaller animal than the last, and of a uniform tawny colour, tending to white on the abdomen and to a dark stripe along the back. The young, as already mentioned, are very distinctly spotted. Like the Tiger, the Puma can endure extremes of heat and cold; it is equally at home in the snow of North America and among the tropical forests and swamps of the south. It is a ferocious creature so far as concerns Deer, Lamas, Raccoons, even Skunks and Rheas, but, according to Mr. W. H. Hudson, will not attack man, and will even defend him against the Jaguar.[1] In captivity the Puma will purr like a Cat.

The Eyra, *F. eyra*, is another self-coloured American cat, which has a curious likeness to the totally distinct *Cryptoprocta* of Madagascar.

The Wild Cat of Europe, *F. catus*, is found over the greater part of Europe, and also in Northern Asia. It was undoubtedly common at one time in this country, though it appears never to have extended its range into Ireland. But the real Wild Cat is now rare in this island, and is confined to certain districts in

[1] But Mr. Belt says that the "Tigre" never attacks man unless it be provoked.

Scotland. Plenty of alleged wild Cats have been seen and even shot; but these are too frequently merely feral Cats, *i.e.* domestic tabbies which have reverted to a hunting life. The real Wild Cat differs from the domestic races by the proportionately longer body and limbs, the shorter and thicker tail; the pads of the toes are not quite black. The period of the gestation of the Wild Cat, according to Mr. Cocks, is a week or so longer than that of any domestic Cat.

The Domestic Cat is in fact regarded as the descendant of the Eastern *F. caffra*, or (perhaps *and*) the closely-allied *F. maniculata*. It is highly probable, however, that after introduction into this country as a domestic animal it has interbred with the Wild Cat. Many allied species of Cats will interbreed, even two so far apart as the Lion and the Tiger. There are interesting archaeological and linguistic reasons for regarding the Domestic Cat as an importation. The legend of Dick Whittington's Cat points to it being a rare and valuable animal, which a tamed *F. catus* would not at that time have been. There was an enactment in Wales of a penalty against him who should kill the king's Cat, again suggestive of its rarity and consequent value. The very name "Puss" is a hint of a foreign origin. Some would derive it from Perse, and upon this is based the notion that the Cat is from Persia. But it seems that Puss is the same as Pasht and Bubastis, showing so far an Egyptian origin for the animal. The ancestral Cats mentioned above are natives of Egypt.[1]

The genus *Cynaelurus*, which includes but a single species, *C. jubatus*, the Cheetah or Hunting Leopard, is separated from *Felis* by a number of characters. In the first place the claws are non-retractile, or at least less retractile than those of the true Cats. It is, moreover, longer legged. The molar is more in a line with the other teeth of the jaw, and the upper carnassial tooth has no inner tubercle. Messrs. Windle and Parsons have lately pointed out many Dog-like features in the muscles. This animal is about as large as a Leopard, but has plain black spots. As its vernacular name implies it is used for sport, and is quite easily tameable. It will purr like the Puma. The Cheetah occurs in India, Persia, Turkestan, and also in Africa; the latter

[1] See E. Hamilton, *The Wild Cat of Europe*, London, Porter, 1896; and M. G. Watkins, *Gleanings from the Natural History of the Ancients*, London, Elliot Stock, 1896.

form is sometimes, though quite unnecessarily, separated as *C. lanigera.* The genus occurs fossil in the Siwalik deposits of India, the species being known as *C. brachygnatha.*

Fam. 2. Machaerodontidae.—This is a family of totally-extinct Cats which range from the Eocene down to the Pleistocene. Their general structure is like that of the Felidae, but they differ in a number of skeletal features. Thus there is an alisphenoid canal, and, as in Bears, there is a postglenoid foramen. There is also a distinct carotid foramen, which does not occur in the true Cats. The teeth are often distinguished by the huge size of the superior canines, which are "weapons for penetrating wounds, without rival among carnivorous animals." These must have been displayed at the sides of the chin when the mouth was closed, and it has even been suggested that the animal possessing these exaggerated canines could hardly have properly closed its mouth. The lower canines were often on the contrary much reduced, and in fact incisor-like In tracing the series of these Cats we find a gradual reduction of the teeth from a more nearly complete number down to the specialised dentition of the existing Cats. The genus *Proaelurus,* Miocene in range, had four premolars in each jaw, and two molars in the lower and one in the upper. This is the greatest number of teeth found in any member of the group.

The resemblance of this genus to *Cryptoprocta* has been insisted upon. *Archaelurus* has suffered a reduction, since one premolar in the lower jaw has disappeared, its formula being thus I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{3}$ M $\frac{1}{2}$. The next stage is shown by *Dinictis* with three premolars in both jaws. There are a good many species of this genus which are all American and Miocene. This genus has five toes upon the hind-feet, and was probably plantigrade It had retractile claws.

In the genus *Nimravus* the dental formula is still further reduced. Another premolar of the lower jaw has gone, the formula being thus I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{3}{2}$ M $\frac{1}{2}$. *Nimravus gomphodus* was a Carnivore about the size of a Panther. It has no third trochanter upon the femur, which process is present in the corresponding bone of *Dinictis.* *Pogonodon* was an equally large animal in which the premolars were three in each jaw, but the molars have become reduced to one in the lower, as they have in this and other genera in the upper

jaw. Finally, *Hoplophoneus* has acquired the dentition of existing Cats.

The Machaerodons, however, show examples with a yet more reduced dentition than that of the most reduced existing Cat, viz the Lynx, which has only two premolars in each jaw and one molar. In *Eusmilus* the molar in both jaws is single, and there is but one premolar in the lower jaw.

The genus *Machaerodus* itself, which appears to include *Smilodon*, is referred by Cope to the true Cats, and not to the Nimravidae, as he terms the family which we have called here the Machaerodontidae. These creatures are known as "Sabre-toothed Tigers," and were of very wide distribution, occurring in South America as well as in Europe and North America. "As nothing," remarks Professor Cope, "but the characters of the canine teeth distinguished these from typical felines, it is to these that we must look for the cause of their failure to continue. Professor Flower's suggestion appears to be a good one, viz. that the length of these teeth became an inconvenience and a hindrance to their possessors. I think there can be no doubt that the huge canines in the Smilodons must have prevented the biting off of flesh from large pieces, so as to greatly interfere with feeding, and to keep the animals in poor condition. The size of the canines is such as to prevent their use as cutting instruments excepting with the mouth closed; for the latter could not have been opened sufficiently to allow any object to enter it from the front. Even when it opens so far as to allow the mandible to pass behind the apices of the canines, there would appear to be some risk of the latter being caught on the point of one or the other canine, and forced to remain open, causing early starvation. Such may have been the fate of the fine individual of the *S. neogaeus*, Lund, whose skull was found in Brazil by Lund, and which is familiar to us through the figures of de Blainville."

Machaerodus is placed among the Felidae on account of the fact that the condyloid and carotid foramina unite with the foramen lacerum posterius. But as in at least one species, *M. palmidens*, there is an alisphenoid canal, which, however, has disappeared in the more recent American forms, it seems permissible to retain the genus in the family Machaerodontidae though its existence reduces the differential character of that family to a minimum. The genus goes back to the Eocene.

Fam. 3. Viverridae.—The Civets, Genets, and their kind differ from the Cats in a number of points. They form, however, by no means so uniform an assemblage as do the Cats; so that the difficulty is, as Dr. Mivart has remarked, not to divide them into sub-families, but to avoid making too many. But before proceeding to subdivide the family we shall describe the characters of the family and contrast them with those of the Felidae.

All the Viverridae are comparatively small creatures. The head and body are more elongate than in the Cats. The fingers and toes are generally five; but there are some (e.g. *Cynictis*) where the formula of the toes is as in the Cats, *i.e.* four on the hind-foot. In the Suricate the fingers are also reduced to four. The claws are perhaps never completely retractile,[1] and often are not at all so. The dental formulae of the genera differ considerably; but in the majority there are more teeth than in the Felidae. The well-known sharp-pointed, conical papillae of the Cat's tongue are not present. The majority have a scent gland beneath the tail, from which the perfume civet is derived. There are a number of osteological characters which differentiate the two families; thus the alisphenoid canal is sometimes present. The bulla is divided, as in the Cats, but is externally constricted.

It seems clear from some at any rate of the characters, *i.e.* the more complete dentition, the five-fingered hands and feet, the non-retractile claws, etc., that the Civets are on a lower level of specialisation than are the Cats.

Sub-Fam. 1. Euplerinae.—The genus *Eupleres* is in many ways the most aberrant type of Viverrid, and is placed in a sub-family, Euplerinae. Its salient feature is the very peculiar dentition: peculiar in the small size of the canines, the canine-like character of the anterior premolars, and the resemblance of the premolars to molars. In some of the characters of the teeth, *Eupleres* is Insectivore-like, and was formerly grouped with that family. There are four premolars and two molars in each jaw on each side. It has five toes upon both fore- and hind-limbs; the skull is very slender. It has no alisphenoid canal. The only species, *E. goudotii*, is of an olive-grey colour, with dark bands across the shoulders in the young. The nose and upper lip are grooved. There are no scent glands. It appears to burrow in the ground, and possibly contents itself with a diet of worms. *Eupleres* is a

[1] The retractility is most marked in the Linsangs.

native of Madagascar, where all the most peculiar Viverridae live.

Sub-Fam. 2. Galidictiinae.—Mivart has placed in this sub-family the three Mascarene genera, *Galidia*, *Hemigalidia*, and *Galidictis*. In them the orbit is not enclosed by bone, there is no alisphenoid canal, and there are five toes and fingers.

Galidia consists of but one species, *G. elegans*, of a chestnut brown colour, with a tail ringed with black. The claws are not retractile. The scent gland is absent. There are five digits upon both hand and foot. There are three premolars and two molars on each side of each jaw. The caecum is (for an Aeluroid) long, and pointed at the apex: it is quite twice the length of that of *Genetta*.

Closely allied to *Galidia* is the genus *Hemigalidia*, of which there are two species. It is distinguished from the last genus by the non-annulated tail It also differs in the dental formula, which is for the molars Pm $\frac{4}{3}$ M $\frac{2}{1}$. This animal is termed by Buffon the Vansire. He correctly enumerates its grinders, and distinguishes it from the Ferret!

Galidictis is a third genus from Madagascar containing two species, one of which has been unfortunately named *G. vittata*, leading perhaps to some confusion with the totally distinct *Galictis vittata*. As in the last two genera the digits are five. The dental formula is that of *Galidia*. It is distinguished from the other two genera of its sub-family by the longitudinal brown striping of the upper part of the greyish body.

Sub-Fam. 3. Cryptoproctinae.—*Cryptoprocta*[1] represents a special sub-family, Cryptoproctinae, and includes only a single species, the Fossa (*C. ferox*) of Madagascar. It is the largest Carnivore of Madagascar, being about twice the size of a Cat, but with an elongated body; the colour is a tawny brown with no striping. The animal is active and lithe in its motions, and is said to be of almost unexampled ferocity in disposition. Its exact systematic position has been much discussed. By Zittel it is placed in a sub-family (including the extinct *Proaelurus* and *Pseudaelurus*) of the Felidae. Mivart and Lydekker, on the other hand, regard it as a genus of the Viverridae. The dental formula of the molars, Pm $\frac{3}{3}$ M $\frac{1}{1}$, is

[1] Beddard in *Proc. Zool. Soc.* 1895, p 430.

more like that of the *Felidae* than of the *Viverridae*, and the teeth are more Feline in structure. The claws of the feet are retractile. As to internal structure the Fossa agrees largely with the Viverridae, but then this family has no very marked points of difference from the Felidae; but where the anatomy does diverge from that of the Felidae it approaches the Viverridae, especially in the muscular system.

FIG. 199.—Fossa. *Cryptoprocta ferox* × ⅛.

The remaining and by far the larger number of genera of Civets are grouped by Professor Mivart in two sub-families: the VIVERRINAE, including the genera *Viverra*, *Viverricula*, *Fossa*, *Genetta*, *Prionodon*, *Poiana*, *Paradoxurus*, *Arctogale*, *Hemigale*, *Arctictis*, *Nandinia*, and *Cynogale*; and the HERPESTINAE, including the genera *Herpestes*, *Helogale*, *Cynictis*, and probably *Bdeogale* and *Rhynchogale*. In the Viverrinae the digits are always five, the claws are more or less retractile, the prescrotal scent glands are usually present, and the anus does not open into a sac. On the other hand, the Herpestinae are characterised by the non-retractility of the claws, the absence of the glands in question, and the fact that the anus does open into a terminal sac.

Sub-Fam. 4. Viverrinae.—*Viverra* includes the true Civets. The genus, save for one African species, is Oriental in range. The molar formula is the complete one for the Viverridae, viz.

Pm $\frac{4}{4}$ M $\frac{2}{2}$. The secretion of the prescrotal gland of *V. civetta* yields the civet of commerce.

The "Rásse," genus *Viverricula,* has been separated generically from the true Civets. It is, remarkably enough, common to both Madagascar[1] and many parts of the Oriental region. It is, moreover, capable of climbing trees, which its relatives are not It has no mane like *Viverra* and is of slighter build.

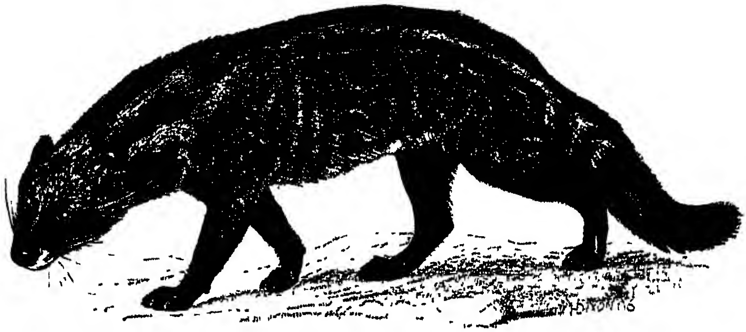


FIG. 200.—Civet Cat. *Viverra civetta.* × $\frac{1}{8}$.

Prionodon or *Linsang* differs from the last two genera in the loss of an upper molar. It thus approaches the Cats, with which it also agrees in the furry feet. It is a purely Oriental genus. It also resembles the Cats in that the claws are apparently quite retractile, a feature not common among the group There are three species of the genus. *P. pardicolor* has large black spots and a ringed tail. Its body is some 15 inches in length Dr. Mivart has commented upon the particularly small caecum, which, like that of *Arctictis,* seems to be on the verge of disappearance.

Genetta, including the Genets, is almost purely African. It has the full tooth formula of *Viverra;* but is to be distinguished by the absence of a scent pouch, and by a naked strip of skin running up the metatarsus. These animals are all brownish yellowish to greyish with darker spots. The Common Genet, *G. vulgaris,* is South European, and just gets into Asia; it is also North African. The Genet, an animal "with an appetite for petty carnage," is one of those smaller Carnivora which are possibly to be regarded as meant by the word γαλῆ, and appear to have "functioned" as Cats among the Greeks. So recently as

[1] Where it has probably been introduced

the times of Belon we are told (by him) that Genets were common and tame at Constantinople.

Poiana, containing a single African species, a spotted and entirely Genet-like animal, has been separated as a distinct genus. Dr. Mivart, however, holds it to be a *Prionodon* which has acquired a Genet-like tarsus.

Arctictis, containing but one species, *A. binturong,* the Binturong, is in some ways an exceptional form. It is a black arboreal creature of not very wide range in the Oriental region, with a fully prehensile tail. This feature and its plantigrade foot with naked sole have led to its being regarded as more allied to the Arctoidea. It is, however, undoubtedly an ally of *Paradoxurus.* The caecum is small, or may be quite absent. The dentition is I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{3}$ M $\frac{2}{2}$. The structure of the animal has been investigated by Garrod.[1]

The genus *Fossa* is a Viverrine confined to Madagascar. There is but one species, *F. daubentoni,* the "Fossane." It is distinguished from *Viverra* by the presence of two bare spots on the under surface of the metatarsus in the hind-limb, and by the absence of a scent pouch. The animal is not much spotted and striped, but the striping in the young is much more marked.

Of the genus *Paradoxurus* there are some ten or a dozen species, belonging entirely to the Oriental region. The teeth are as in *Viverra,* but occasionally the molars are reduced to one. The pupils are vertical. The tail though long is not prehensile, "but the animal appears to have the power of coiling it to some extent, and in caged specimens the coiled condition not unfrequently becomes confirmed and permanent" (Blanford). This fact accounts for the name *Paradoxurus;* for a prehensile tail is hardly to be expected in an animal of the zoological position of the Palm Civets, and yet its occasional twisting led originally to the view that it was so. The genus has scent glands. The dentition is I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{2}{2}$. *P. niger,* the Indian Palm Civet, is, like other species, not often to be seen in a wild condition. It is arboreal, and, like other members of the genus, feeds upon a mixed diet, consisting of all kinds of small Vertebrata and insects, varied by fruit. Another species, *P. grayi,* is so distinctly vegetarian in its habits that it makes considerable havoc in pine-apple beds in the Andaman Islands.

[1] *Proc. Zool. Soc.* 1873, p. 196.

Arctogale is another Oriental genus with very small teeth, those of the molar series being hardly in contact. The soles of the feet are more naked than in the last genus, and the scent glands, if present, appear to be small and ill developed. It has also a long tail, and is arboreal in way of life. There is "nothing particular recorded" as to its habits. The species are *A. leucotis* and *A. stigmatica*.

Closely allied to both the last genera is *Hemigale*, also an Oriental genus. It is to be distinguished from *Paradoxurus*

FIG. 201.—Hardwicke's Civet Cat. *Hemigale hardwicki*. × $\frac{1}{6}$ (From *Nature*.)

by having the soles of the feet much less naked, though they are more so than in *Viverra* or *Prionodon*. The coloration of the species, *H. hardwicki* (a Malayan animal), is very peculiar. The body is banded with five or six broad transverse stripes, and the basal portion of the tail is also ringed, an uncommon feature in the group. A second species of this genus is *H. hosei*, from Borneo. It is blackish in colour, but is not a melanic variety of the last.

Nandinia appears never to possess a caecum.[1] It is also peculiar among Carnivora in the non-ossification of the hinder

[1] Flower, *Proc. Zool. Soc.* 1872, p. 683.

part of the bulla. It is an African genus, containing two species which are spotted. The tail is ringed.

Cynogale is at any rate a partially aquatic, short-tailed, web-footed, reddish brown-coloured Civet, which lives upon fish and Crustacea, and inhabits the Malay Peninsula, Sumatra, and Borneo. It has long "moustaches," and is said to have a head bearing a singular resemblance to the head of the Insectivorous "Otter" *Potamogale*. The metatarsus is bald, and the pollex and hallux are very well developed.

Sub-Fam. 5. Herpestinae.—There are over twenty species of *Herpestes* (Mongooses) divided between the Ethiopian and Oriental regions, one species, *H. ichneumon*, being also found in Europe. The fur has a "pepper and salt" appearance; the feet are plantigrade. There are five fingers and toes. The pollex and hallux are small; the tail is long. The tarsus and metatarsus are usually naked. The Egyptian species "has been injudiciously denominated the Cat of Pharaoh." It is perhaps better known as Pharaoh's Mouse. The beast is so far Cat-like that it will destroy Rats and Mice; and it has been exported to sugar plantations for that very purpose. More famous are its combats with venomous serpents. According to Aristotle and Pliny the Ichneumon first coats its body with a coating of mud, in which it wallows, and then with this armour can defy the serpent. Topsell tells the tale better. The Ichneumon burrows in the sand, and "when the aspe espyeth her threatening rage, presently turning about her taile, provoketh the ichneumon to combate, and with an open mouth and lofty head doth enter the list, to her owne perdition. For the ichneumon being nothing afraid of this great bravado, receiveth the encounter, and taking the head of the aspe in his mouth biteth that off to prevent the casting out of her poison." In the West Indies the animal has been described as fearlessly attacking the deadly Fer de Lance and receiving its bites with impunity; it is also added that it will eat the leaves of a particular plant as an antidote! The real explanation of the result of these encounters is of course the agility of the Ichneumon[1]—*fort cauteleuse beste*, as Belon says.

Another species, *H. albicauda*, is distinguished, as the name denotes, by its white tail. A species of this genus, *H. urva*,

[1] See also vol. viii. p. 591.

sometimes raised to generic rank as *Urva*, is partly aquatic in habit; it feeds upon crabs and frogs, but is quite willing to take to poultry and their eggs.

Helogale is a genus whose validity appears doubtful (to Dr. Mivart). It is African, and contains two species.

FIG 202.—White-tailed Ichneumon. *Herpestes albicauda.* × 1/8

Cynictis is an African genus, with five digits on the fore-limbs and four on the hind. As in *Herpestes*, the orbit is completely encircled by bone. There is but a single species, *C. penicillata*, which is of a reddish colour and has a bushy tail.

Bdeogale, also African, has the toes still further reduced; there are only four on both limbs. The tarsus is hairy and the tail bushy. They are "very rare animals, and nothing is known of their habits." It is known, however, that they will kill poisonous snakes, for Dr. Peters took a Rhinoceros Viper out of the stomach of one.

Rhynchogale[1] differs from all other genera of Viverridae, except *Crossarchus* and *Suricata*, in having no groove upon the muzzle. There are five digits. There is the full Viverrine dentition, with five premolars in the upper jaw; but this may be an abnormality.[2]

Crossarchus differs from the last in only having three premolars on each side of each jaw. It is also African, and there are several species.

Suricata is the last genus of Viverridae; it is also African, and contains a single species, *Suricata tetradactyla*, the "Meerkat" of the Cape. The Suricate has but four toes on each foot; the tarsus and the metatarsus are naked below. The body is banded posteriorly. There are fifteen dorsal vertebrae, and the orbit is

[1] The original name was *Rhinogale*.

[2] That it is an abnormality has been recently stated.

closed by bone. The Suricate lives in caves and rock crevices, and will dig burrows. It is distinctly a diurnal animal, and sits upon its hind-legs after the fashion of a Marmot. As Buffon noticed in a tame specimen (thought by him to be a native of Surinam), the animal barks like a dog. The Suricate is largely vegetarian, living upon roots.

FIG. 203.—Suricate. *Suricata tetradactyla.* × ¼.

Fam. 4. Hyaenidae.—Unlike though the Hyaenas appear to be to the last family—mainly perhaps on account of size—they are, nevertheless, very nearly akin to them, more so than to the Cat tribe. It will be remembered that the striping and spotting of the Hyaenas is very Genet- and Suricate-like.

There are admittedly two genera among the Hyaenidae, *Hyaena* itself with three species,[1] and the Aard Wolf, *Proteles*, with but one. But Dr. Mivart considers that the Spotted Hyaena should form a genus apart, *Crocuta*—a proceeding which was initiated by the late Dr. Gray of the British Museum. The Hyaenidae are to be distinguished by the following characters:—There are generally four toes, always so in the hind-foot. The claws are non-retractile. The nose and upper lip are grooved. The molar formula is Pm $\frac{4}{3}$ M $\frac{1}{1}$. The soles of the feet are covered with hairs upon the tarsus and metatarsus. No scent glands. Tail short. Dorsal vertebrae more numerous than in other Aeluroids, *i.e.* fifteen. The bulla is divided by a rudimentary septum only.

[1] For the anatomy of Hyaenas see Morrison Watson in *Proc. Zool. Soc.* 1877, p. 369; 1878, p. 416; and 1879, p. 79.

The genera *Hyaena* and *Crocuta*, the Striped and Spotted

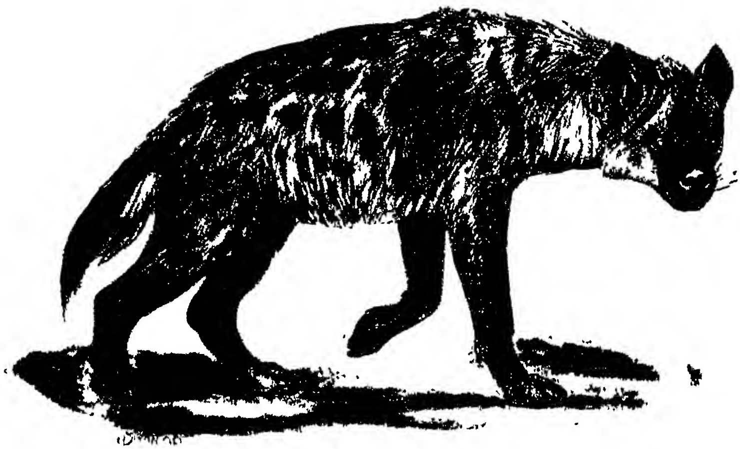


FIG. 204.—Spotted Hyaena. *Crocuta maculata.* × 1/12

Hyaena respectively, are African and Asiatic in range, *Crocuta* being limited to South Africa. There is neither hallux nor pollex

The Hyaenas, stigmatised by Sir Samuel Baker as "low-

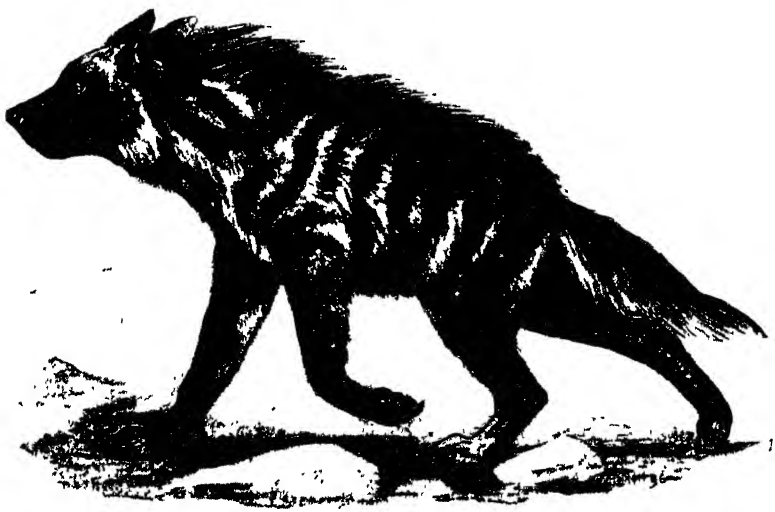


FIG. 205.—Striped Hyaena. *Hyaena striata.* × 1/12

caste creatures," are mainly carrion feeders. Much Arab superstition is associated with them. Certain peculiarities in the structure

of the organs of reproduction have led to the belief that a Hyaena changes its sex every year. Its almost human-sounding howls are supposed to be a deliberate trap for the unwary traveller. There is also a legend that in the eye of the Hyaena is a stone which if placed under the tongue of a man endows him with the gift of prophecy.

Proteles presents many resemblances to the Hyaenas, but also certain differences; by many it is placed in a separate family. There is but one species, *P. cristata*, the Aard Wolf of South Africa. In outward aspect it is very Hyaena-like, the coat being striped, and the ears, though longer, resembling those of a Hyaena. There is also a mane. There are, however, five toes on the fore-feet. The teeth are feebler, particularly the molars, which are also reduced in number. The skull, as in *Hyaena*, has no alisphenoid canal, but the bulla tympani is divided by a septum. The animal seems to feed largely upon insects, particularly Termites, and also upon carrion.[1]

Of extinct Hyaenoids *Ictitherium* seems to be transitional between them and the Viverridae. Its dentition, $\frac{3}{3}$, $\frac{1}{1}$, $\frac{4}{3}$, $\frac{2}{1}$, is that of a Viverrid, and the feet are five-toed. The upper carnassial tooth, however, is like that of *Hyaena* in having a strong inner cusp. Other extinct genera of Hyaenas are *Lycyaena* and *Hyaenictis*. The genus *Hyaena* itself goes back as far as to the Miocene, and occurred in Europe until the Pleistocene. The Cave Hyaena of this country seems to be indistinguishable from *Crocuta maculata*, though it has received the name of *H. spelaea*.

Fam. 5. Canidae.[2]—This family cannot be divided into more than five genera, and is universally distributed with the exception of New Zealand. The auditory bulla is smooth and rounded, and has internally a very incomplete septum, extending through about one-fourth or one-third of the cavity. The meatus has a fairly prominent under lip. The paroccipital process is long and prominent. The mastoid is distinct, though but slightly developed. The glenoid foramen is large; the condyloid foramen is conspicuous, and the carotid canal is deep within the foramen lacerum posterius. The last three characters are Bear-like; the

[1] Flower, *Proc. Zool. Soc.* 1869, p. 457.

[2] For a general account of the Canidae see Mivart, *A Monograph of the Canidae*, London, 1890.

form of the bulla is Aeluroid. The teeth vary somewhat in number, and the following table will serve to indicate the gradual reduction observable in the number of molars:—

Otocyon	I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{3 \text{ or } 4}{4}$
Canis generally	I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{3 \text{ or } 2}{4 \text{ or } 3}$
Cyon	I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{2}{2}$
Icticyon	I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{2 \text{ or } 1}{2}$

All the Dogs have a caecum[1] of simple cylindrical form. In *C. cancrivorus*, *C. jubatus*, and *Nyctereutes procyonides* this organ is straight or only very faintly curved; in other Dogs it is coiled into an **S**-like form, sometimes with an additional twist. The Dogs have, as a rule, five toes, one being dropped in *Lycaon*. The tail is fairly long and distinctly bushy. There is in a number of species a gland at the root of the tail, the presence of which can frequently be detected by the wet appearance due to the oozing secretion. The great majority of existing Canidae belong to the genus *Canis*. But certainly three, and more doubtfully four, other genera can be distinguished.

The genus *Icticyon* contains but one recent species, the Bush Dog (*I. venaticus*, Lund) of British Guiana. The animal has a somewhat Paradoxure-like, at any rate a distinctly un-dog-like, aspect, being longish in the body (some 2 feet long), shortish in the legs, and big-headed. It is blackish in colour, verging towards golden brown on the head and back. Sir W. Flower, to whom we owe our chief knowledge of its structure, characterises it as like a young Fox, and with the playful manners of a puppy. The animal appears to hunt in packs and by scent, and has a reputation for ferocity. *Icticyon* differs from *Canis* and agrees with the Indian *Cuon* in having but forty teeth, the last molar having disappeared from the upper and lower jaws. The caecum, unlike that of the majority of Canidae, is only slightly curved. The brain, oddly enough, shows a Cat-like peculiarity. It has been pointed out that in their long bodies and short legs the genera *Cuon* and *Icticyon* resemble the primitive dogs.[2]

A genus *Nyctereutes* is usually separated from *Canis* for the inclusion of *N. procyonides* only. The separation is based upon

[1] Flower, *Proc. Zool. Soc.* 1879, p. 766.
[2] *Proc. Zool. Soc.* 1880, p 70.

the strikingly unusual coloration of this Dog. It is a small animal, with numerous long white hairs dorsally. The face, chest, and much of the belly are black. Its aspect distinctly recalls that of a Raccoon,[1] especially in the black patches below

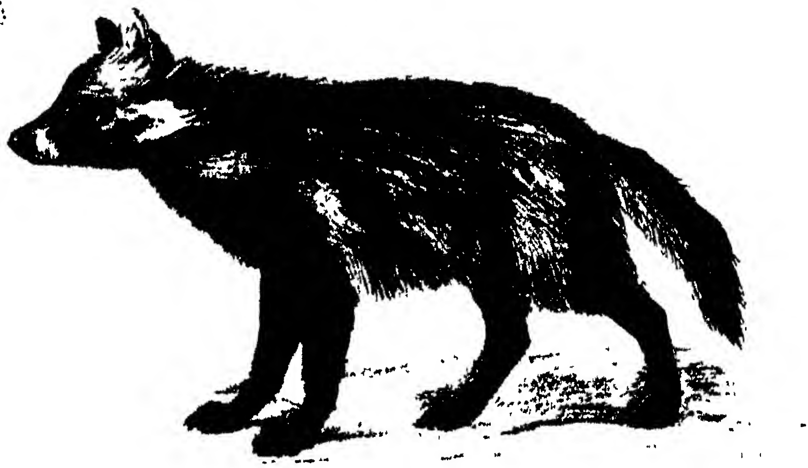


FIG. 206.—Raccoon-like Dog. *Nyctereutes procyonides.* $\times \frac{1}{8}$.

the eyes, whence of course the scientific name and the pseudo-vernacular "Raccoon-like Dog." It inhabits China and Japan. As to structure, there is hardly anything that justifies its exclusion from the genus *Canis.* Garrod, however, mentions the unusually large size of the Spigelian lobe of the liver.

Wortman and Malkens[2] have instituted a genus *Nothocyon* for Dr. Mivart's species *C. urostictus*[3] and *C. parvidens,* which are both South American forms.

The genus *Otocyon* contains but one species, *O. megalotis,* an African species, ranging pretty widely in that continent (from the Cape to Somaliland, in sandy districts), and sometimes confused with the Fennec on account of its long ears. Its principal structural difference from other Dogs is that there is an additional molar in each jaw, the molar formula being thus M $\frac{3}{4}$ or even $\frac{4}{4}$. Moreover the carnassial teeth are not so pronounced, and Professor Huxley laid especial stress upon the

[1] The relationship between the Canidae and the Procyonidae must not be lost sight of in considering this point of external likeness.

[2] *Bull. Amer. Mus. Nat. Hist.* xii. 1900, p. 109.

[3] *Proc. Zool. Soc.* 1890, p. 98.

likeness of some of the cheek teeth to those of the more primitive Arctoids. The angle of the lower jaw is inflected, a character, however, which seems to be more general than is usually allowed among animals not referable to the Marsupials. It is possible that *Otocyon* is a persistent Creodont-like form which has developed in a direction curiously, and in a most detailed fashion, parallel to the Dogs. If, however, we may assume the addition of the molar, then this anomalous but not necessarily untenable conclusion is obviated.

The genus *Cuon*, or *Cyon*, has been instituted for the two or three species of Eastern Dogs (*C. primaevus*, *C. dukkunensis*, etc.) which agree with each other in the constant loss of a molar in the lower jaw, or, it should be said, almost constant loss, for the missing tooth is occasionally represented. The latter of the two species mentioned, the Dhole, is, like its congeners, an animal which hunts in packs; it is said to hunt even the ferocious Tiger, and to be thus one of the few animals which can face the largest and fiercest of the Carnivora.

The genus *Lycaon* is a very distinct type, being differentiated from other Dogs by the possession of only four toes on both fore- and hind-limbs, and by the dental formula, which is Pm $\frac{4}{4}$ M $\frac{2}{3}$. The one species is *L. pictus*, the Cape Hunting Dog. It is singularly like a Hyaena[1] in general appearance; the ochraceous grey ground-colour with black markings and the long ears produce this likeness. The animal has got its vernacular name from the habit of hunting in packs. Its range is over a good part of Africa. The occurrence of this species (or at least genus, for the name *L. anglicus* has been used) in caves in Glamorganshire seems to show that it is a comparatively recent immigrant into Africa. As to its visceral structures, *Lycaon*[2] does not differ widely from other Dogs. It has, however, no lytta beneath the tongue. The intestines are thus divided: large, 9 feet 1 inch; small, 1 foot 3 inches. This contrasts with the proportions observable in some other Dogs. While other Dogs have but a cartilaginous rudiment of the clavicle, *Lycaon* has a considerably larger representative of this bone.

The bulk of the Dogs, Wolves, Foxes, and Jackals are thus left over for inclusion in the genus *Canis*. But the numerous

[1] Temminck, its original describer, placed it in the genus *Hyaena*.

[2] See Garrod, *Proc. Zool. Soc.* 1878, p. 373.

members of this genus can, according to Professor Huxley, be sorted into two series by certain cranial characters. The two

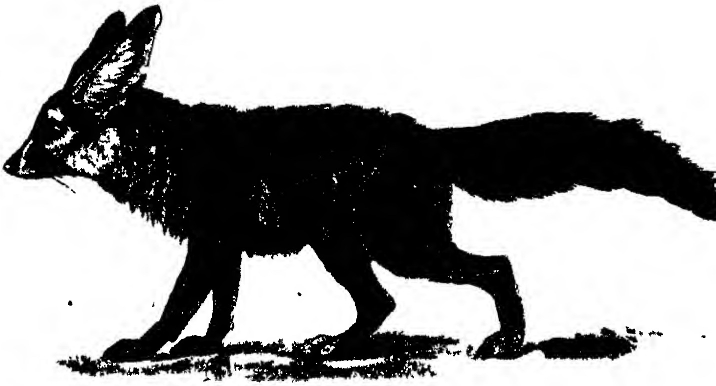


FIG. 207.—Fennec Fox. *Canis zerda.* × 1/5.

series he termed the "Alopecoid" or Fox-like, and the "Thooid" or Wolf-like. It was suggested that the generic name *Vulpes* be

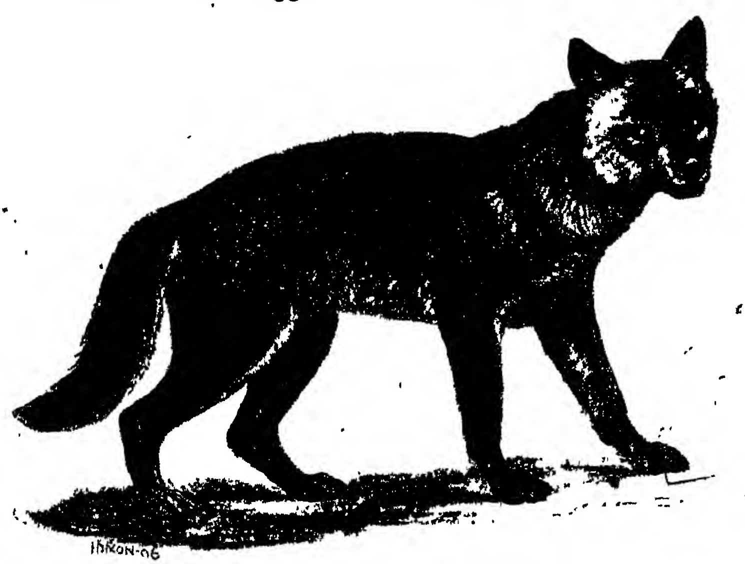


FIG. 208.—Prairie Wolf or Coyote. *Canis latrans.* × 1/8.

used for the former, and *Canis* for the second. The characters which will be dealt with immediately are also to be noted among

the Dogs belonging to genera that have already been separated off. Thus *Lycaon* is distinctly Thooid. The characters in question are these:—In the Fox series, the frontal air-sinus of the Thooids is absent; the cranial cavity is pear-shaped, without an abrupt angle coinciding with the supra-orbital sulcus, such as exists in the other group; the coronoid process of the mandible is rather higher and more turned back in the Foxes, while the depth of the mandible at the level of the first molar is greater.

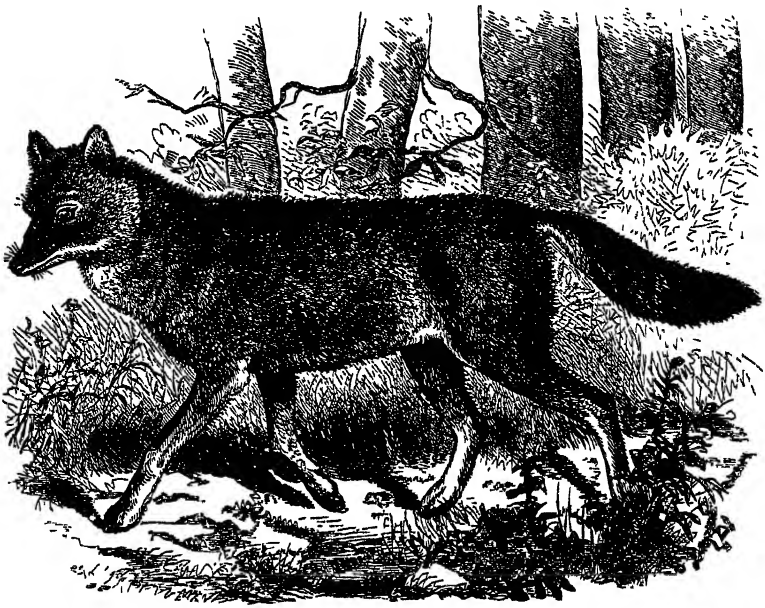


FIG. 209.—Japanese Wolf. *Canis hodophylax.* × ⅛. (From *Nature.*)

To the Fox series belong among others the species *C. lagopus* (Arctic Fox), *C. zerda* (the Fennec), *C. chama* (the Silver-backed Fox of Africa), *C. virginianus* (the Virginian Fox), *C. velox* (the Kit Fox), and of course the Common Fox of this country. On the other hand, the Dogs proper (such as *C. dingo*), the Wolves (*C. lupus, C. pallipes, C. niger*), the Japanese Wolf (*C. hodophylax*), the Red Wolf of America (*C. jubatus*), the Jackals (*C. aureus, C. anthus,* etc.), the Prairie Wolf (*C. latrans*), and a number of American forms, such as *C. azarae*, its close ally *C. cancrivorus* (= *C. rudis*), *C. antarcticus*, *C. magellanicus*, etc., are decidedly Wolves rather than Foxes.

The Arctic Fox, *Canis lagopus*, is known by its bluish summer and pure white winter dress as "Blue Fox" and "White Fox" respectively. It is an inhabitant of the Arctic north; but in former days, as its remains show, it descended to such southern latitudes as Germany and this country. The most southern point which it now inhabits is Iceland. This small Fox is well known as being one of the few animals which change their dress to a complete white in winter. This change is, however, not absolutely universal; and M. Trouessart has even stated that the supposed change does not exist, but that the colours are a question of age and sex. This Fox feeds on birds and cast-up carcases of Whales and Seals; it is also said to devour shell-fish, and actually to store up food when abundant for seasons of scarcity. A Fox has been observed to "carry off eggs in his mouth from an eider duck's nest, one at a time, until the whole were removed"; and in winter to "scratch a hole down through very deep snow to a *cache* of eggs beneath." These anecdotes are told by Sir Leopold M'Clintock; but others have also asserted the storing habits of this Fox, which really has only a short time of the year in which it can catch suitable living food.

Canis vulpes, the Fox, is not only a native of England, but extends as far to the east as Egypt, the so-called *C. aegyptiacus* being at most a mere variety. Varieties indeed occur in these islands; the English Fox being redder, the Scotch greyer. Not only is the Fox a truly indigenous English beast, but its remains go back a very long way into past time. Its bones occur in the Red Crag, a deposit of Pliocene times. Its prevalence now is no doubt due to its preservation as a beast of chase. It lives in burrows, either excavating them itself or taking possession of those of some other animal; the Badger suffers in this way, and is said to be vanquished not by the teeth of the burglarious Fox, but by its far fouler habits! It is curious that the expression "foxing" is not so suitable to this animal as to many others. The habit of "shamming death" is a widely-spread one in the animal world, but at least not common with our Fox. The sagacity of the Fox appears to be a little more proverbial than actual; literature teems with its accomplishments. The worthy Archbishop of Upsala, Olaus Magnus, figured Foxes dipping their tails in the streams, and then pulling out inquisitive crayfishes

which had seized upon them. "It is a crafty, lively, and libidinous creature," observed a writer of the last century.

Of Jackals there are many species, both African and Oriental. Mr. de Winton allows the following list of African species[1]:—*C. anthus, C. variegatus, C. mesomelas, C. lateralis. C. mesomelas* is distinguished by the broad black patch in the middle of the back. These animals do not appear to go in packs as so many Canidae do; they live upon carrion, but also rob hen-roosts, and commit other depredations upon the live stock of farmers. The "Quaha," *C. lateralis,* is distinguished from the last by its sharp bark, and by the obvious side stripe which has given to it its name. It is curious that it should live in apparent amity with *C. mesomelas,* since the habits of the two are identical and would lead, one might suppose, to a severe struggle for existence, in which one of the two would disappear. Of Indian Jackals *C. aureus* is the most familiar type.

The European Wolf, *Canis lupus,* was once, but is no longer,

FIG. 210.—Wolf. *Canis lupus.* $\times \frac{1}{8}$.

an inhabitant of the British Islands. Their former prevalence is indicated by many names of towns and villages, such as Ulceby and Usselby in Lincolnshire, the town of Wolverton, and Woolmer Forest. In Saxon times Wolves were very abundant; and even so recently as the reign of Elizabeth they were to be seen on

[1] *Proc. Zool. Soc.* 1899, p. 533.

Dartmoor and in the Forest of Dean. In the New Forest they were hunted in the twelfth century. It would seem that the last English Wolf was slain some time during the reign of Henry VII. In Scotland, however, they persisted very much longer. So recently as 1743 was the last killed. But before this period they had begun to get exceedingly scarce, for the price of a skin in 1620 is quoted at £6 : 13 : 4. In Ireland Wolves lingered yet longer; about 1770 is believed to be the date of their final extinction in that island. The Wolf nowadays is distributed over the greater part of Europe, Northern Asia, and North America, the American form not being considered to be distinct from its European ally. Much legend has collected round this fierce Carnivore. Aristotle, usually accurate in the main, still "states more of wolves than experience warranted." Pliny, unable to sift truth from falsehood, was in this matter "an eager listener to all old women's tales." Aelian added to his marvels and asserted that the Wolf cannot bend its head back; if it should happen to tread on the flower of the squill it at once becomes torpid. So the wily fox, fearing his more powerful enemy, takes care to strew his path with squills! The conversion of men into Wolves was a well-known superstition, dating from Grecian and Roman times; it formed the basis of much of the witchcraft persecutions of the Middle Ages and onwards, and has left its mark in folklore, *e.g.* the Wolf in "Red Riding Hood."

The Indian Wolves, *C. pallipes*, *C. chanco*, and *C. laniger*, are hardly, if at all, different from *C. lupus*. Professor Huxley has remarked upon the likeness of *C. pallipes* to a Jackal, thus bridging over the very inconsiderable gap that may be held to divide Jackals and Wolves.

The Dingo, *Canis dingo*, is an interesting and somewhat mysterious species of Dog or Wolf. As is well known, it is an Australian species; but it does not seem to be certain whether it was tamed and brought over to Australia by the native races, or is a true and indigenous Australian species.

The colour of this species varies, but is usually of a reddish brown; it is, however, often grey and indeed almost black. Whether indigenous or introduced, the Dingo is a plague to Australian settlers, devouring Sheep, which it generally destroys by tearing out the paunch. It does not as a rule hunt in packs. The Dingo is stated to feign death with so much persistence that

an individual has been known to be partly flayed before moving Dingo remains have been found in river-gravels in Australia where no human remains have been detected. This argues for its indigeneity; but, on the other hand, it has been pointed out that man himself in the Australian continent goes back a very long

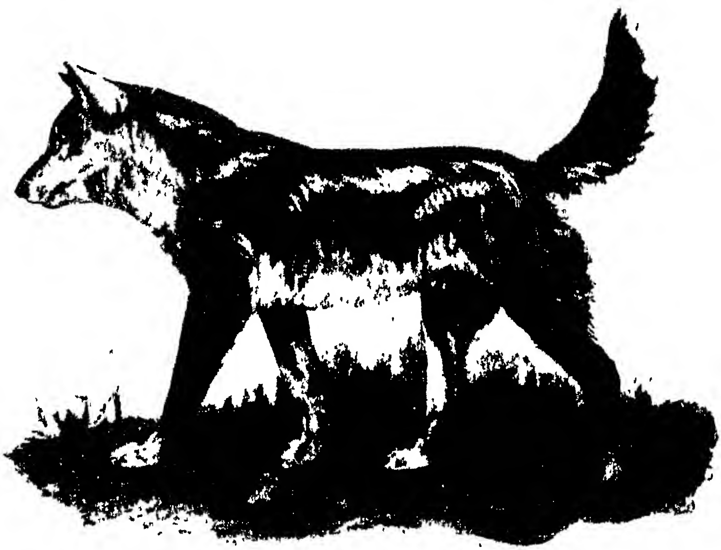


FIG. 211.—Dingo. *Canis dingo* × $\frac{1}{8}$.

way into time, and may thus still have imported this companion with him. Anyhow it is quite a wild creature now. Dr. Nehring, an expert investigator into the subject of domestic animals, has stated that the skeleton of the Dingo does not suggest a feral animal at all but a purely wild race.

The Domestic Dog is usually spoken of as *Canis familiaris*; but to remains in bone caverns the name of *C. ferus* or *C. mikii* has been given. There seems to be no doubt that the Dog was the "friend of man" in very early times. Its remains have been met with in Danish kitchen-middens, in the lake-dwellings of the Swiss lakes, and during the Bronze Age in Europe generally. But "there are few more vexed questions in the archaeology of natural history than the origin of the dog." Its remains already referred to may in many cases have argued its use as food. But in a Neolithic barrow a Dog was found buried with a woman, the

skeletons of both being *in situ*; this animal was about the size of a Shepherd Dog. The actual Dog of to-day is divisible into more than 180 different breeds; but in a work upon "Natural History" it would seem out of place to enumerate and characterise these artificial products. Authors vary in their opinion as to what stock gave rise to the domestic races of the past and of to-day. The Jackal, the Bunasu (*C. primaevus*), the Indian Wolf (*C. pallipes*), have been proposed as likely ancestors. It is more probable that there is much admixture, and that various wild types have been selected by man in various countries.

Extinct Canidae.—Many of the existing species of Canidae are also to be found in Pleistocene deposits of the countries which they now inhabit. A few show a wider range in the immediate past than in the present. Thus *Lycaon* (*L. anglicus*) has been met with in caves in Glamorganshire, while *Icticyon* of South America appears to be congeneric with *Speothos* of the Brazilian caves. The African *Otocyon* seems to occur in deposits in India. There are also numerous extinct species belonging to the genus *Canis*, which extend as far back as the Pliocene.

The earlier types of Dogs have been placed in different genera. *Cynodictis* is an Eocene form from European strata. The skull is decidedly Civet-like, with a short snout. The fore- and hind-feet were five-toed, with well-developed pollex and hallux. The dentition was that of modern Dogs, the molars being two in the upper and three in the lower jaw. The general aspect of the creature and the form of the skeleton was much like that of the Viverrine genus *Paradoxurus*, of which, as well as of the Dogs, *Cynodictis* might have been an ancestor.

Simocyon of the Upper Miocene serves as the type of a separate sub-family of Dogs, Simocyoninae. The skull is short, broad, and high; the shortening of the skull affecting the jaws has reduced the teeth greatly; the first three premolars are very small, fall out soon, and are thus often deficient. There are only two molars in each jaw. This type is of course nowhere near the ancestral Dog. It is a much-specialised branch of an early type. *Cephalogale* is less specialised; there are the usual four premolars. *Enhydrocyon* is an intermediate form; it has lost one premolar in each jaw.

Amphicyon, forming the type of another sub-family, Amphicyoninae, though usually placed among the Dogs, presents us with

many Bear-like features in its organisation. The feet, for instance, were plantigrade and five-toed. The ulna and the radius are specially compared with the same bones in the Bear tribe. The skull on the other hand is as distinctly Dog-like in form. The molars are large, broad, and crushing, and Bear-like. The largest known species, *A. giganteus*, is of about the size of the Brown Bear. *Amphicyon* is a Miocene genus. Eocene and allied to it is *Pseudamphicyon.* This genus has, like *Amphicyon,* the complete dentition of forty-four teeth. In the Amphicyoninae generally the feet are five-toed, the humerus has an entepicondylar foramen and the femur a third trochanter. The upper molars are large.

The closely allied and American genus *Daphaenus* has also plantigrade feet, and has in its structure many reminiscences of the Creodonts So, too, has the Eocene *Uintacyon.*

Cynodesmus is closely allied to *Cynodictis.* It has ancient features combined with quite modern ones. The skull is described as being Creodont-like, but the dentition is that of the microdont modern Dogs. In accordance with its age the cerebral convolutions of this Dog are much simpler than in existing Dogs, and the hemispheres do not cover the cerebellum so much.

The Bear-like Carnivora or Arctoidea.—That division of the Carnivora which is typically represented by the Bears embraces three recent families, which are united by a number of characters. These Carnivora are always plantigrade or nearly so. They have nearly always five toes. The claws are not retractile, or at most semi-retractile as in the Panda. In the skull the tympanic bulla is often depressed, and is not so globular and obvious as in the Cats. Its cavity is not divided by a septum. The paroccipital processes are not applied to it. The carnassial tooth is less emphasised in this group than in the Cats.

These characters, however, have to be used with caution, as they are hardly universally applicable. A fairly typical Arctoid bulla is seen in such a form as *Cercoleptes.* The bulla itself is a little more swollen than in *Ursus,* but it is flattened off in the same way towards the bony meatus. The paroccipital processes, slightly developed, are at a distance of $\frac{1}{4}$-inch from the posterior margin of the bulla. In the Raccoon the bullae are much more swollen, and the paroccipital processes are closer to them. In the Marbled Polecat, *Putorius sarmaticus,* the bullae are fairly

swollen, and there is but little flattening towards the meatus: the paroccipital processes, though slight, are in contact with the bullae basally, though their free tips are turned away from them. Finally, in *Ictonyx* the bullae are much swollen; there is but little flattening towards the meatus, and the paroccipital processes, themselves much swollen, are pressed closely against the bullae. The Mustelidae, therefore, in this as in other characters, approach the Aeluroids.

There is no caecum, a feature which marks off the Arctoidea from all Carnivora except the Viverrids *Nandinia* and *Arctictis* (occasionally). The brain is characterised by the possession of

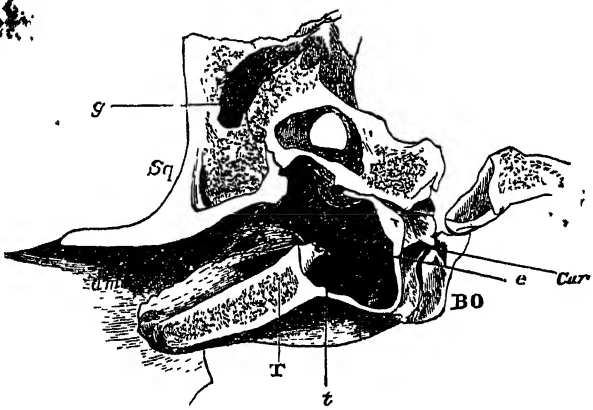


FIG. 212.—Section of the left auditory bulla and surrounding bones of a Bear (*Ursus ferox*). *am*, External auditory meatus; *BO*, basioccipital; *Car*, carotid canal; *e*, Eustachian canal, *g*, glenoid canal; *Sq*, squamosal, *T*, tympanic; *t*, tympanic ring. (From Flower, *Proc. Zool. Soc.* 1869.)

what Dr. Mivart has described as the "ursine lozenge," a tract about the middle of the hemispheres, defined posteriorly by the crucial sulcus, and formed by the emergence on to the surface of the brain of the hippocampal gyrus.

The Arctoidea are very widely distributed. But there are some curious exceptions. Thus there are no representatives of the group (as might be expected) in the Australian region; they are completely absent from Madagascar; while the true Bears (family Ursidae) are totally absent from Ethiopian Africa, and are only represented by a single species, *Ursus ornatus*, in the Neotropical region.

It is noteworthy that the Arctoidea never show spots or

cross stripes (save rings on the tail), which are so common a feature of the coloration of the Cat-like forms.

In bracketing together the three families which are described in the following pages, emphasis is laid upon a number of undoubtedly common features. Palaeontology seems, however, to suggest that the Mustelidae come nearer to the Viverridae. That the Bears and Dogs are connected by extinct annectent genera does not interfere with their present distinctness.

The systematic arrangement of these Carnivora is not easy. It may be useful, however, to give a method of arrangement for the convenient placing of the genera.

The most primitive group is perhaps that of the true Bears, family Ursidae; for in them the molars are two above and three below, and have thus not become diminished in number as in some of the other members of the order. Moreover, the Bears have lobate kidneys, which character, often occurring in the young of animals which when adult have smooth kidneys, may be looked upon as a primitive character. The feet furthermore are completely plantigrade. This family will contain only three genera, *Ursus*, *Melursus*, and *Aeluropus*.

Next comes the family Procyonidae, in several members of which one molar is lost below, though in others the more archaic formula is retained. The kidneys are simple. This family contains the American genera *Procyon*, *Nasua*, *Bassariscus*, *Bassaricyon*, *Cercoleptes*, and the Old-World form *Aelurus*.

The third family, Mustelidae, has the molar formula reduced to $\frac{1}{2}$ or $\frac{1}{1}$. The kidneys are simple except in the Otters. To this family are assigned the following genera:—*Arctonyx*, *Conepatus*, *Meles*, *Mephitis*, *Taxidea*, *Mydaus*, *Mellivora*, *Helictis*, *Ictonyx*, *Mustela*, *Galictis*, *Grisonia*, *Putorius*, *Gulo*, and the aquatic *Lutra*, *Enhydris*, and *Aonyx*.

Fam. 6. Procyonidae.—This family is mainly American in range, the genus *Aelurus* alone being a native of the Old World. But Zittel would include with the genera of this family the Viverrine and Oriental genus *Arctictis*, a proceeding which is perhaps hardly admissible, though the occasional absence of a caecum in that animal is so far in favour of such an alliance. The largely vegetable nature of its food and its arboreal habits cause a certain amount of likeness to some of the members of the present group of Carnivores. The Procyonidae have two

molars in either half of each jaw. The carnassial teeth are not typically developed, and the molars are broad and tuberculate. The tail is long, often prehensile, and often ringed in the disposition of its colour pattern. The alisphenoid canal is absent save in the aberrant *Aelurus*. Both condyloid and postglenoid foramina are present. The members of this family are plantigrade.

The genus *Procyon* includes at least two species of Raccoon, the northern form, *P. lotor*, and the South American, *P. cancrivorus*. To these may possibly be added a third, *P. nigripes*. This genus is characterised by the length and the mobility of

FIG. 213. Raccoon. *Procyon lotor*. × ⅛.

the fingers, and indeed it uses its hands greatly. It has no median groove upon the muzzle, which is found in many other Arctoids; the ears are moderately large; the tail is not long, being about one-third of the entire length of the animal, including the tail. The soles of the feet are naked. Its limbs are very long (for an Arctoid), and this gives to the animal a bunched-up appearance when walking. There are four premolars and two molars on each side of each jaw. There are fourteen pairs of ribs, of which ten pairs reach the sternum. The latter is composed of nine pieces.

The first-named species has received its name from the fact—of which there is abundant proof—that it dips its food into water. As a matter of fact, the animal frequents the margins of streams, and hunts in the shallow water beneath stones for cray-

fish, and it also captures fish. Not only is this animal partially aquatic, but it can climb well—"they make their homes in trees, but carry on their business elsewhere." The animal can be readily tamed, but is a tiresome pet on account of its insatiable curiosity and its skill in the use of its hands, which enables it to unlatch doors and generally to pry about everywhere. The Raccoons are mostly nocturnal creatures.

The genus *Bassaricyon*[1] includes two species, both American, *B. alleni* being from Ecuador, and *B. gabbii* from Costa Rica. They have so much the aspect of a Kinkajou that a specimen, which arrived at the Zoological Gardens, was presented and entered as one of those animals. Nevertheless there are many differences between the two genera. The tail of *Bassaricyon* is

FIG 214.—Bassaricyon. *Bassaricyon alleni.* × ⅛.

not prehensile, and the animal, as will be seen from Fig. 214, has a sharper snout; the brain is more like that of *Bassariscus*. The likeness to *Cercoleptes* can hardly perhaps be regarded as an example of "mimicry" since the forms are so nearly related, and the advantage of such an imitation remains to be proved. The muzzle of *Bassaricyon* is grooved; the ears are fairly large; the soles of the feet are naked; there is but a single pair of teats. There are two molars and four premolars to each half jaw.

The dorsal vertebrae are thirteen in number; nine of the ribs reach the sternum. The slenderness and convexity of the lower margin of the lower jaw, as well as the feeble angular process, distinguish this genus from its undoubtedly near ally *Cercoleptes*. The dental formula also is different.

Bassariscus has a ringed tail like a Raccoon, and is also American in range; it furthermore agrees with the Raccoon in

[1] See Beddard, *Proc. Zool. Soc.* 1900, p. 661, for anatomy.

being nocturnal and mainly arboreal in habit. There are apparently three species, of which *B. astutus* is the best known, having been on several occasions exhibited at the Zoological Society's Gardens, the last examples so lately as 1900. The animal was for a long time believed to be allied to the Oriental Paradoxures, and its occurrence in America was therefore puzzling. The real affinities of the creature were, however, definitely set at rest by Sir W. Flower, and later accounts of its anatomy have confirmed

FIG. 215.—Cunning Bassarisc. *Bassariscus astutus.* × 1/5. (From *Nature*)

that opinion.[1] The vertebrae are more numerous than in *Procyon*, and the teeth are slightly different; otherwise it presents many likenesses to its nearest ally. The ears are long; the nose is grooved; and the palms and soles are naked.

The Kinkajou, *Cercoleptes*, is likewise an American Arctoid. It ranges from Central Mexico down to the Rio Negro in Brazil. It was at one time confounded, and, considering its external appearance, not unnaturally, with the Lemurs. Sir R. Owen dispelled this view by a careful dissection of the creature. Nevertheless, there are certain anatomical features in which it differs

[1] Bed[illegible] *Proc. Zool. Soc.* 189[illegible] 129.

from Carnivora and resembles Lemuroids.[1] It has been pointed out that the form of the lower jaw "much resembles that of the Lemuroid *Microrhynchus*." There is, however, no doubt that it is rightly placed in the present group. The tail is very prehensile, and the animal is therefore, as might be supposed from this circumstance, purely arboreal. It has some twenty-eight verte-

FIG. 216.—Kinkajou. *Cercoleptes caudivolvulus.* $\times \frac{1}{8}$.

brae. This genus has a median groove upon the nose. The claws are long and sharply pointed, and the palms and soles of the feet are naked. The premolars are three, the molars two. There are fourteen dorsal vertebrae, of which nine are united to the nine-jointed sternum by ribs. There is but one species, *C. caudivolvulus*, of a uniform yellowish-brown colour.

Nasua, the Coati, ranges from Texas to Paraguay, and has

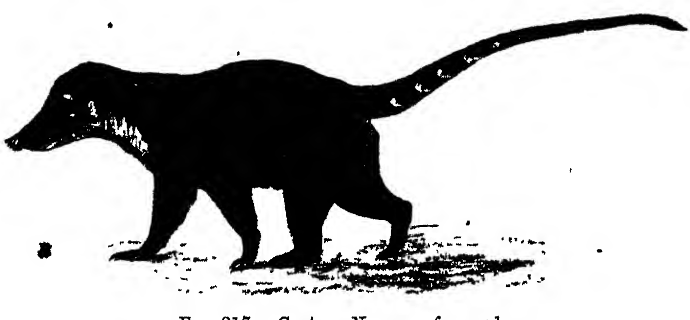


FIG 217.—Coati. *Nasua rufa.* $\times \frac{1}{8}$.

two species. In Guatemala it reaches a height of 9000 feet on the mountains. The nose is produced into a short and very

[1] It is a curious fact that a native name for the creature is "Pottos" (cf. of course *Potto*); and indeed the generic name *Potos* seems to have the priority over *Cercoleptes*.

mobile proboscis, hence its name. The native Mexican name for the creature is "Quauhpecotl."

The Coati is largely arboreal, and hunts iguanas in large bands, some of them being on the trees and some on the ground beneath. It also grubs up worms and larvae, for which purpose its long snout is suited. The molars of the genus resemble those of *Procyon*.

There is not a median groove upon the nose. The palms and soles are naked. Six teats occur. There are thirteen dorsal vertebrae. *Nasua nasica*[1] and *N. rufa* are the best known and perhaps the only species. The colour of the fur varies a good deal, and has led to the use of other names for supposed species.

Aelurus, the Panda, is a largish animal found in the south-eastern Himalayas up to a height of 12,000 feet. It has a glossy fur of a reddish colour, and a "white somewhat cat-like face." The molar formula which distinguishes it from the New-World Arctoids belonging to the Procyonidae, as well as from its possible ally *Aeluropus*, is Pm $\frac{3}{4}$ M $\frac{2}{2}$. The anatomy of the animal has been described by Sir W. Flower.[2] Dr. Mivart has pointed out that the muzzle though short is upturned in a way distinctly recalling that of *Nasua*. The animal inhabits forests, and feeds almost entirely upon vegetable food. It eats eggs, however, and insects. Though living to a great extent upon the ground, it is also arboreal, and has sharp semi-retractile claws. It is said to be dull of sight, hearing, and smell, and yet with these disadvantages is also unprovided with cunning or ferocity. Its habits have been compared with those of a Kinkajou.

Fossil Procyonidae.—In addition to several of the existing genera, the remains are known of various extinct forms of Procyonidae. *Leptarctus*, with one species, *L. primaevus*, is of Pliocene age, but is known only by one ramus of the lower jaw. It appears to "offer a number of transitional characters between the more typical Procyonidae and the aberrant *Cercoleptes*."[3]

Fam. 7. Mustelidae.—Contrary to what has been stated with regard to the habits of the Procyonidae, the Mustelidae are for the most part "bloodthirsty robbers," and are spread over the

[1] "*Narica*" is generally written, after Linnaeus. But this was, according to Mr. Alston, probably an error for *nasica*.

[2] *Proc. Zool. Soc.* 1870, p. 752.

[3] See Wortman, *Bull. Amer. Mus. Nat. Hist.* vi. 1894, p. 229.

whole surface of the world, with the exception of Australia and Madagascar. The molar teeth are generally reduced to one in the upper jaw, and sometimes to one in the lower jaw, which thus gives "a sort of *prima facie* resemblance to the feline dentition." There is no alisphenoid canal; postglenoid and condyloid foramina are found.

Sub-Fam. 1. Melinae.—Of this sub-family there are representatives both in the Old and New Worlds.

Meles, the Badger, is exclusively Palaearctic in range.[1] Dr. Mivart says that *Meles* has a relatively longer dorsal region than any other Carnivore, and that it is most nearly approached by

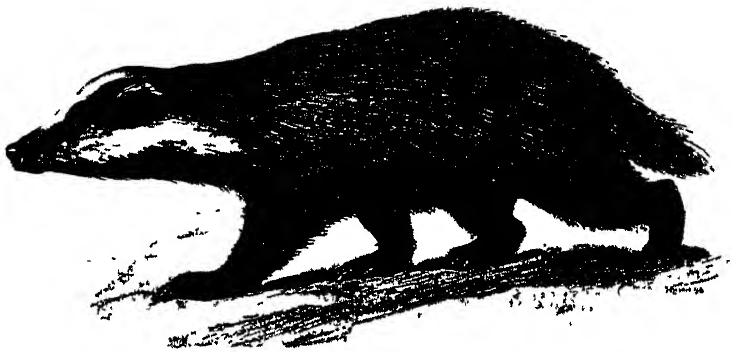


Fig. 218.—Badger. *Meles taxus*. $\times \frac{1}{8}$

its allies *Ictonyx* and *Conepatus*. The molar formula is, as in *Arctonyx*, *Mydaus*, and *Helictis*, Pm $\frac{4}{4}$ M $\frac{1}{2}$. The molars differ from those of any other Carnivore in the much greater size of the first molars than of the last premolars. The nose is not grooved; the soles of the feet are naked. The claws of the fore-feet are much longer than those of the hind-feet.

The genus *Arctonyx* is a "pig-like badger" from Hindostan, Assam, and North China. The epithet "pig-like" is derived from the long and mobile snout, which is truncated and has terminal nostrils. It is remarkable for having a part of the palate formed by the pterygoids, as in Whales and certain Edentata (e.g. *Myrmecophaga*). There are sixteen dorsal vertebrae. *A. collaris* lives in

[1] As a small point of likeness between this Mustelid and the Procyonidae may be mentioned the colours of the face. *M. anakuma* is particularly Raccoon-like.

fissures of rocks, or in holes dug by itself. It is a purely nocturnal beast.

The singular genus *Mydaus*, containing the species *M. meliceps*, the Teledu or Javanese Skunk, is an inhabitant of Java and Sumatra. It frequents the mountains of these islands, into the soil of which it burrows in search of worms and larvae. There is but one species, which is "like a miniature badger, of rather eccentric colours." It is blackish brown, with a yellowish-white top to its head, and a stripe of the same colour down the back. It may be distinguished by its elongated snout, obliquely truncated, and with inferiorly-placed nostrils. As to osteological characters, it has a more oblique symphysis of the mandible than in any other Carnivore. The secretion of the anal glands is said to rival that of the Skunk in offensiveness and in the distance to which it can be propelled.

Sub-Fam. 2. Mustelinae.—Representatives occur in both the Old and New Worlds; but the genera and even the species are in one or two cases common to both.

Galictis barbara,[1] the Tayra, is a brown, elongated, and Weasel-

FIG. 219. Tayra. *Galictis barbara.* × ¼.

like animal from Mexico and South America. As is the case with the Weasel, it is sometimes gregarious, a herd of twenty having been observed. The soles of the feet are naked, and the molar formula is Pm $\frac{3}{3}$ M $\frac{1}{2}$. In these characters the Grison (*G. vittata*) agrees with *G. barbara*; but it has been referred to a different genus, *Grisonia*.

The Grison, "this savage and diabolical-looking weasel," as

[1] See *Trans. Zool. Soc.* ii. 1841, p. 201.

Mr. Aplin terms it,[1] is known also as the "Hurón." It almost rivals the Skunk in the power of the odour which it can emit when enraged. A trapped specimen was placed in a cage 50 yards or so from the house, and even at this distance it was disagreeably easy to tell when any one visited the animal—at least when the wind set in the right direction. It is greyish yellow above and blackish beneath, presenting, as has been

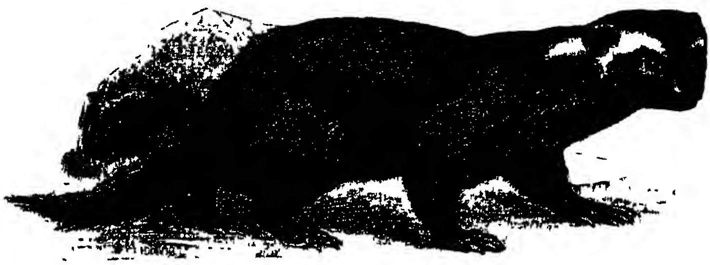


FIG. 220.—Grison. *Grisonia vittata.* × ¼.

remarked, a curious similarity to the Ratel. The nose of this animal is destitute of a median groove, which is present in the Tayra; the soles of the feet, however, are naked as in that animal, and it is nearly plantigrade in walk. It differs also from *Galictis* in having sixteen[2] instead of fourteen dorsal vertebrae. Eleven of the ribs reach the sternum. Considering the differences that exist between some other genera of Arctoids, it may be fairly allowed that a genus *Grisonia* is tenable.

G. allamandi is darker coloured than the Grison, with a white band from the forehead to the neck. Mr. T. Bell described a tame individual as eating eggs, frogs, and even a young alligator.

A third genus of this group has recently been founded by Mr. Oldfield Thomas[3] for a small African animal, which is Grison-like in its coloration. The name given to the genus, *Galeriscus*, is intended to suggest its likeness to the Grison (*Galera* or *Grisonia*). The chief distinctive feature of this genus, whose skeleton is not yet known, is the presence of only four digits on each limb; the pollex and the hallux being entirely absent. The ears of this Grison are short.

[1] *Proc. Zool. Soc.* 1894, p. 306.

[2] I found fifteen

[3] *Ann. Nat. Hist.* (6) xiii. 1893, p. 522.

The genus *Mustela* includes the Martens and Sables, which are distinguished from the following genus by the molar formula, which is Pm $\frac{4}{4}$ M $\frac{1}{2}$. The same character separates them from *Galictis*, and also the generally hairy under surface of the feet. In more southern latitudes, however, the palms are sometimes naked. The nose is grooved, and the ears are short and broad. The genus is widely distributed, being common to the Old and New Worlds. In the Old World it extends from Europe to Java, Sumatra, and Borneo. The largest species of the genus is the American Pekan, an animal which may be 46 inches in length, including the tail. There are two species of Sable, one European (*M. zibellina*), the other American.

The only British species of the genus is the Pine Marten, *M. martes*. It is dark brown, with a brownish-yellow throat, and reaches a length of some 17 inches, with an eight-inch tail. It is getting rare, but is still fairly common in the Lake country. The animal is largely arboreal in habit, whence the vernacular name. It is also called Marten Cat. The allied *M. foina*, the Beech Marten, has been stated to be, but apparently is not, an inhabitant of these islands. The colour of the animal is a rich brown. It has small eyes and ears and a short tail. The palms of the hands and the soles of the feet are hairy; the muzzle is naked, and has a groove as in *Cercoleptes*, etc.

The Glutton, *Gulo*, is a well-marked genus, containing but one species, which is circumpolar in range. The dentition is Pm $\frac{4}{4}$ M $\frac{1}{2}$. The ferocity but not the voracity of this animal appears to have been exaggerated. It mainly feeds on carcases, and is not really a successful hunter. As to the carcases, Olaus Magnus tells in straightforward language the way in which the animal dilates in size during a meal, and presently, after following the practice of the ancient Romans, returns to the banquet: "Creditur a natura creatum ad ruborem hominum qui vorando bibendoque vomunt redeuntque ad mensam"!

This is one of the few land animals which ranges completely round the pole. There is no difference to be noted between the Old-World and the New-World specimens. It is now an entirely northern form, but in Pleistocene times it reached as far south as this country. The fossil species seems to be *Gulo luscus*, and to be quite indistinguishable from the living forms.

Putorius, the genus which embraces the Weasel tribe, contains

many species known popularly as Weasels, Ermines, Stoats, Ferrets, Polecats, Minks, and Vison. Not only is the genus common to both Old and New Worlds, but in a few cases the species (e.g. *P. erminea*) range from Asia to America. The molar formula is

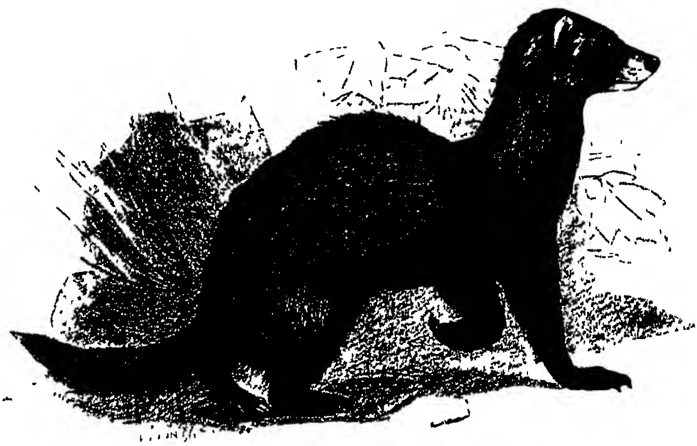


FIG. 221.—Polecat. *Mustela putorius.* × ⅛.

Pm $\frac{3}{3}$ M $\frac{1}{2}$. The form of the body is an exaggerated one, the length of the trunk to the limbs being very great. The feet are more or less hairy beneath, and the animals are digitigrade. The nose is grooved. The dorsal vertebrae vary from thirteen to sixteen.

There are four British representatives of this genus:—

The Polecat, *P. foetidus,* is a dark brown-coloured animal. Its total length is about 2 feet, of which the tail occupies some 7 inches. It is a species banned by the gamekeeper, and hence is approaching extinction in this country. It is excessively bloodthirsty, as are apparently all the members of this genus, and kills out of mere wantonness. The Ferret is simply a domesticated variety of the Polecat.

The Stoat or Ermine, *P. erminea,* is reddish brown above, white beneath. In winter, in certain localities, it becomes white with the exception of the black tip of the tail. This colour-change bears some relation to the degree of latitude. It is universal in the north of Scotland, rare in the south of England. As is the case with some other animals that generally change

their colour in the winter, there are individuals which seem to have lost the power of change, and others which change in an apparently capricious manner, not influenced by season or cold. Like so many other animals, the Stoat appears at times to migrate, which it does in large parties. Such parties are said to be dangerous, and will attack a man who crosses their path.

The Weasel, *P. vulgaris*, has much the same colour as the Stoat, but is a smaller animal; it differs also by undergoing no seasonal change. It is equally agile and ferocious, and ought to be encouraged, as it vents its ferocity largely upon Voles and Moles, which it can pursue underground. Like other species of *Putorius*, it seems to kill its prey by biting through the brain-case.

The fourth British species is the recently-described Irish Stoat, *P. hibernicus*. It is somewhat intermediate between the last two.

Poecilogale is a genus recently instituted by Mr. Thomas for a small South African Weasel, *P. albinucha*, coloured like the Zorilla, *i.e.* with whitish stripes upon black, but differing in its reduced molar formula, which is Pm $\frac{2}{2}$ M $\frac{1}{1}$ or $\frac{1}{2}$.

Lyncodon[1] is thought to be more doubtful; it is South American (Patagonian), with the same molar formula as the most reduced forms of the last genus, *i.e.* Pm $\frac{2}{2}$ M $\frac{1}{1}$. The ears are short and almost invisible; the claws of the anterior limbs are long, those of the hind limbs short. It is not quite certain that it is not "an aberrant southern form of *Putorius brasiliensis*." That its distinction is justifiable appears to be shown by the discovery in the same region of a fossil species, *L. luganensis*. Matschie places it near *Galictis*.

The Ratel, *Mellivora*, is common to India and West and South Africa. It is a black animal with a grey back and grey on the top of the head, the contrast of colour suggesting a dorsal carapace. It runs with a swift trot. The animal lives much on the ground, but can climb trees. It is exclusively nocturnal in its habits. It has the reputation in India of feeding upon dead bodies, a view which has probably no foundation in fact save that it can burrow. The molar formula is Pm $\frac{3}{3}$ M $\frac{1}{1}$. There are fourteen dorsal vertebrae. The African and Indian species are

[1] See Matschie, *SB. Ges. Naturf. Berlin*, 1895, p. 171.

hardly to be distinguished from each other. The ears are very minute. The tail is short. The muzzle is rather pointed, and the soles and palms are naked.

FIG. 222 —Ratel. *Mellivora capensis.* $\times \frac{1}{6}$.

The structure of *Helictis* has been described by the late Professor Garrod,[1] as well as by Sir W. Flower in his general account of the Carnivorous skeleton. The animal, which is a native of East Asia, is sometimes gaily coloured. *H. subaurantiaca*, the species dissected and figured by Garrod, is a varied black and orange. The genus is arboreal, and the tail may be moderately long and bushy. The ears are small; the nose is grooved; the palms are naked, but the soles of the feet are hairy. There are fourteen dorsal vertebrae. The molar formula is Pm $\frac{4}{4}$ M $\frac{1}{2}$.

The Zorilla, *Ictonyx*, is the last of the Old-World genera of Melinae. It is African, ranging from the tropical parts of the continent to the Cape. "In colour and markings," remarks Dr. Mivart, "as well as in the odour of the secretion of its anal glands, the one or two species which form this genus resemble the skunks; so much so that did they inhabit the same region, and were they devoid of an offensive secretion, they would certainly be said to mimic the skunks." The molar formula of the genus is Pm $\frac{3}{3}$ M $\frac{1}{2}$. There are fifteen dorsal vertebrae. The nose is grooved and the soles partly hairy.

The American Badger, *Taxidea*, is a burrower of omnivorous tastes, and correlated with the former habit are the immense

[1] *Proc. Zool. Soc.* 1879, p. 305.

claws of the fore-paws. It is North American, but gets into Mexico. The molar formula is as in the American genera *Mephitis* and *Conepatus*, and as in the Old-World *Ictonyx*, and it thus differs from that of *Meles*. Besides the great size of the claws upon the hand, which are larger relatively than those of any other Carnivore, the genus *Taxidea* is to be distinguished from all Arctoids (indeed, from all Carnivora) except *Mydaus*, by the fact that the pelvic limb is of the same length as the pectoral. The muzzle is furry except at the very extremity; this is grooved. The animal is carnivorous, subsisting upon the following very varied kinds of food—"Spermophiles, Arvicolas, birds' eggs, and snails, also honey-comb, wax, and bees."

The Skunk, *Mephitis*, is an American animal with several species, which range from North to Central America. The black-and-white colour distinguishes the genus, which is furthermore marked by the fact that the third digit of the hand is relatively longer than in any other Carnivore except *Taxidea*. The soles are partly hairy. It is a terrestrial fossorial animal with well-known powers of protecting itself from aggression. But nevertheless the Skunk has its enemies, and is not quite so unmolested as is sometimes popularly supposed. The Puma, Harpy Eagle, and the Great Horned Owl will at least occasionally attack and devour it. The molar formula is Pm $\frac{3}{3}$ M $\frac{1}{2}$. There are sixteen dorsal vertebrae.

Conepatus is a more southern form of Skunk, extending down into South America. Its dentition is like that of *Mephitis* save for the loss of an upper premolar. This genus, which has been further subdivided, differs from *Mephitis* in the fact that the soles of the feet are wholly naked, whereas in *Mephitis* those of the hind-limbs are partially hairy. It has no groove on the nose. Its tail is shorter than that of *Mephitis*. This Skunk has the same habits as the last. In certain parts of South America the animals are so abundant and their odour so powerful that in the evening there is generally a recognisable smell about. This is said to be good for the headache!

Sub-Fam. 3. Lutrinae.—Of this sub-family there are at least two genera. *Enhydris* (*Latax*),[1] the Sea-Otter, is confined to the shores of the North Pacific. It is more purely aquatic than are

[1] Lydekker, "Note on the Structure and Habits of the Sea-Otter (*Latax lutris*)," *Proc. Zool. Soc.* 1895, p 421; and *ibid.* 1896, p. 235.

other Otters. Specimens have been seen swimming fifteen miles from land. The gait of the creature when on land is suggestive of a marine animal; the webbed hind-feet are doubled back upon the knuckles during progression upon land, and locomotion is effected by a series of short springs from these feet, the Otter does not walk "in ordinary acceptance of the term." The tail is flattened, being twice as broad as it is thick, and ends in a bluntish point. *Enhydris* feeds mainly upon crabs and sea-urchins, but also upon fish. Its dental formula is peculiar by reason chiefly of the reduction of the lower incisors. The formula runs as follows: I $\frac{3}{2}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{1}{2}$.

The molar teeth of this creature, in accordance with its diet, have lost the sharp points of the Mustelidae in general; the crowns are flattened, and the tubercles very blunt. In this it contrasts with *Lutra*, and presents some resemblance to the Crab-eating Raccoon, *Procyon cancrivorus;* but the teeth are still further blunted. *Enhydris* feeds largely upon sea-urchins and shell-fish, and needs blunt teeth for the crushing of the hard shells of its prey. It is interesting to notice that the habits of this animal have been altered by the interference of man. The creature has been hotly pursued for a long time on account of its valuable fur. Instead of feeding and breeding upon the shore in places readily accessible to its pursuers, the Sea-Otter has now taken to the open sea in a greater degree. It utilises masses of floating seaweed for those purposes, and hunts for its food in the deeper water at a greater distance from the shore. In conjunction with the increasing rarity of the Sea-Otter the price of its skin has enormously increased: whereas in 1888 the average price per skin was £21 : 10s., the value of a fine skin now is at least £100, and as much as £200 and even £250 has been given. The animal is captured by netting and by clubbing and spearing.[1] From the Miocene Siwalik beds remains of an allied form, *Enhydriodon,* have been obtained, whose teeth are somewhat intermediate in their crowns between *Lutra* and *Enhydris.*

Lutra, including the Otters, is widely distributed. Both manus and pes are webbed. The ears are small and hairy. The nose is not grooved, and the naked part is very circumscribed;

[1] See an article by Mr. Lydekker in *Knowledge,* April 1898, from which many of the above facts have been taken.

the claws upon the hind-feet are flattened and somewhat nail-like. There are about ten species, but of course, as is so universally the case, a great many more names have been given. The molar formula is like that of *Enhydris* save that there is an extra premolar in the upper jaw. There are fourteen pairs of ribs, of which eleven pairs reach the ten-jointed sternum. The caudals are twenty-three. The Cape Otter, the "clawless" Otter, has been separated as a genus *Aonyx*. So too has the South American *Pteronura brasiliensis*. But in neither case is the separation allowed by Mr. Thomas in a recent revision of the genus.[1] The latter species has the reputation of being very fierce, and is known in

FIG. 223.—Otter. *Lutra vulgaris*. × ⅛.

Uruguay by the name of "Lobo de pecho blanco." The British species, *L. vulgaris*, reaches a length of 2 feet or so, with a tail of 16 inches; it ranges over the whole of Europe and a large portion of Asia. This Otter often burrows in the banks of the streams which it frequents; and in the burrow in March or April the female brings forth her young, three to five in number. It will also frequent the sea-coast.

Fossil Mustelidae.—Besides a number of the existing genera there are fossil members of this family which cannot be referred to existing genera. These latter extend back into time as far as the Eocene. *Stenoplesictis*, one of these Eocene forms referable to the sub-family Mustelinae, is to be distinguished

[1] "Preliminary Notes on the Characters and Synonymy of the different Species of Otter," *Proc. Zool. Soc.* 1889, p. 190.

from living Mustelines by its comparatively long legs. In this genus as in several others there are two upper molars.

Fam. 8. Ursidae.—This family is nearly universal in distribution, and consists of but three genera, *Ursus, Melursus,* and *Aeluropus.*

Ursus has the palms and soles naked except in the Polar Bear, which needs a furry sole to walk with ease upon ice surfaces. The ears are fairly large, and the nose may or may not be traversed by a median groove.[1] The molar formula[2] is Pm $\frac{4}{4}$ M $\frac{2}{3}$. The brain is naturally (because of the size of the animals of this genus) richly convoluted. The lobate kidneys have already been mentioned in defining this family (see p. 426).

A very large number of species of Bears have been described.

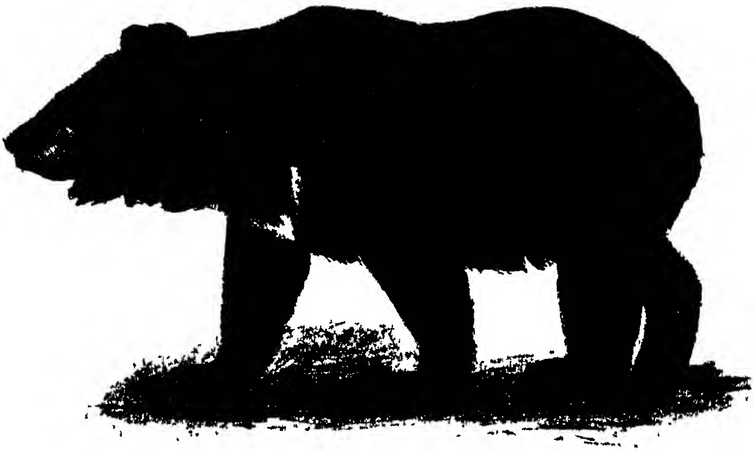


FIG. 224.—Himalayan Bear. *Ursus tibetanus.* $\times \frac{1}{15}$.

But it is the opinion of Mr. Lydekker[3] and of others that many of these are really to be referred to the European Brown Bear; in this event the Grizzly of North America, the Isabelline Bear, the Syrian Bear, a Bear from Algeria, the Kamschatkan and Japanese Bears, besides the extinct *Ursus fossilis* of Pleistocene caves, are to be regarded as slight modifications of *Ursus arctos.* On the other hand, the great Cave Bear, *U. spelaeus,*

[1] Even apparently in the same species.

[2] The number of premolars is reduced in the Polar Bear.

[3] "The Blue Bear of Thibet," etc., *Proc. Zool Soc.* 1897, p. 412.

and the Thibetan Blue Bear (*U. pruinosus*) are distinct species, not to be confounded with *U. arctos*. Neither, of course, are the Peruvian *U. ornatus* and the Sun Bear, *U. malayanus*.

The Polar Bear has even been placed in a separate genus, *Thalassarctos*, a proceeding which is quite unnecessary. The white colour of this Bear tends to become browner with age. It is one of the few mammals which extend right round the pole; the Polar Bear is of course a purely Arctic animal. The chief food of the Polar Bear is Seal. Out of thirty Bears examined, Mr.

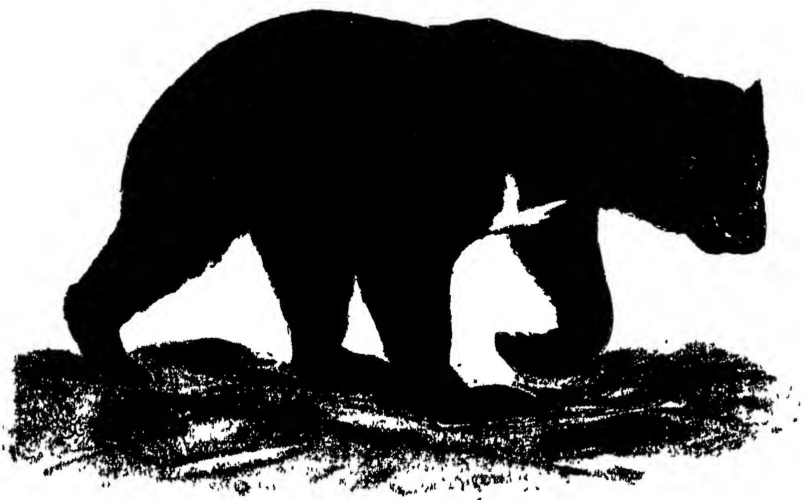


FIG. 225.—Malayan Bear. *Ursus malayanus.* $\times \frac{1}{12}$.

Koettlitz found that only fifteen had animal remains in their stomachs, and these remains were invariably Seal. The animal apparently hunts by scent rather than by sight or hearing, both of which senses seem to be somewhat dull. The males and females wander separately, except of course during the breeding season The Bears dig holes in which they may remain for some time, but there is no hibernation. In Pleistocene times, the Polar Bear extended as far south as Hamburg. The female has four mammae, pectoral in position.

Melursus includes only *M. labiatus*, the Sloth Bear of India. This animal has an upturned snout, which is described as closely resembling that of *Mydaus*, the Teledu. The snout has no groove.

All Bears are largely vegetarian and insect feeders; but this Bear is especially so. It delights in the nests of Termites, and its energy in destroying these hills for the sake of their inhabitants is so great that the name of "sloth" appeared to Sir Samuel Baker to be an entire misnomer.

Aeluropus, a rare Carnivore with but one species, *A. melanoleucus*, is not inferior in size to the Brown Bear, and is distinguished by its largely white coloration. It was discovered in the mountains of East Thibet by Père David, and described by Milne-Edwards[1] as a distinct and new genus, the discoverer himself having named it as a species of *Ursus*. It is a vegetable-

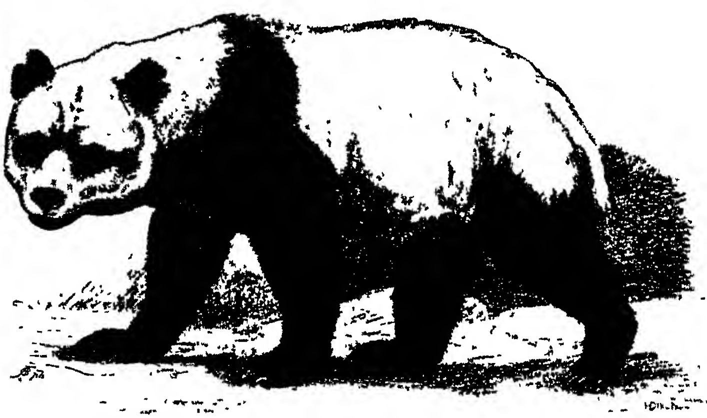


FIG. 226.—*Aeluropus melanoleucus*. $\frac{1}{12}$.

feeding creature and bulky in form, with a rudimentary tail and a short broad head; in fact, more like a Bear than a Procyonid (with which group it is placed by some). The width of the head, however, is greater than in any other Carnivore; it is most closely approached in this by *Aelurus* and by *Hyaena*. The molar formula is Pm $\frac{4}{3}$ M $\frac{2}{3}$. The soles are hairy. There is no alisphenoid canal. The molars are especially large and multicuspid.

Fossil Ursidae.—The genus *Ursus* itself goes back to Pliocene times. The well-known Cave Bear, *Ursus spelaeus* of

[1] *Nouv. Arch. Mus.* vii. 1872, *Bull* p. 92; and *Recherches pour servir à l'histoire naturelle des Mammifères*, 1868-1874, p. 321 This genus has quite recently (Lankester, *Trans. Linn. Soc* viii. 1901, p. 163) been definitely referred to the Procyonidae

Pleistocene times, was one of the commonest of Carnivorous creatures during the very early times of the present era. It was as huge as a Polar Bear or a Grizzly. The skull is remarkable for the fact that the first three premolars, which are small in all Bears, dropped out early in life. An immense number of names have been given to what are in all probability the same species as this Cave Bear of remote antiquity.

Hyaenarctos is the oldest genus of true Ursidae. It goes back into Middle Miocene times, and ranged over Europe and North Africa.

Arctotherium is an American genus of Pleistocene times. The likeness of some of the extinct Canidae to Bears has been already commented upon.

CHAPTER XIV

CARNIVORA (*CONTINUED*)—PINNIPEDIA (SEALS AND WALRUSES)—CREODONTA

SUB-ORDER 2. PINNIPEDIA

THIS group includes the Seals, Sea-Lions, and Walruses,[1] all aquatic and, for the larger part, marine creatures. Being aquatic they have to some extent acquired a fish-like form, though not so completely as have the Whales and even the Sirenia. This is most complete so far as the group is concerned in the Seals, where the hind-limbs have become soldered to the tail and are inefficient as walking legs, where the external ears have vanished, and where the general shape of the body is tapering and thus fish-like. The Walruses and Sea-Lions are less modified in this direction; in the latter (not in the former) the external ear, though small, is persistent, and the hind-limbs are capable of being used as organs of progression upon dry land. The general characters applicable to the Carnivora, given upon a previous page, apply to the Pinnipedia.

The characters confined to the Pinnipedia as a whole are mainly these:—The greater part of the limbs are enclosed within the skin, the hands and feet are fully webbed, and there is a tendency for the nails to disappear, and for the phalanges to increase in number—characters which are clearly not diagnostic of the order but correlated with an aquatic life, since they reappear, and are indeed exaggerated, in the Cetacea. The teeth are peculiar in that the milk dentition is feeble and is early shed. This, as it were, undue emphasis upon one of the two sets of teeth is another likeness to the Whales,

[1] For the genera of Pinnipedia see Mivart, *Proc. Zool. Soc.* 1885, p. 484

where, however, it is the milk dentition that is most pronounced, the "permanent" being feeble and very early shed. But the dentition of the Pinnipedes presents other likenesses to the Cetacea, which are, it must be remembered, regarded by some as a modification of the Carnivorous stock, in which case, of course, the likenesses may be genetic rather than due to adaptation in the two cases. There is a distinct tendency towards a homodont series, the grinding teeth being often very simple, and the very distinct carnassial tooth of many terrestrial Carnivores being absent. Finally, the number of the back teeth shows some signs of being on the increase; and Professor Kükenthal has found that this increase is due to the division of existing teeth. Here is a point of likeness to the many teeth of the typical Toothed Whales. Dr. Nehring found in several examples of *Halichoerus grypus* the normal five back teeth increased to

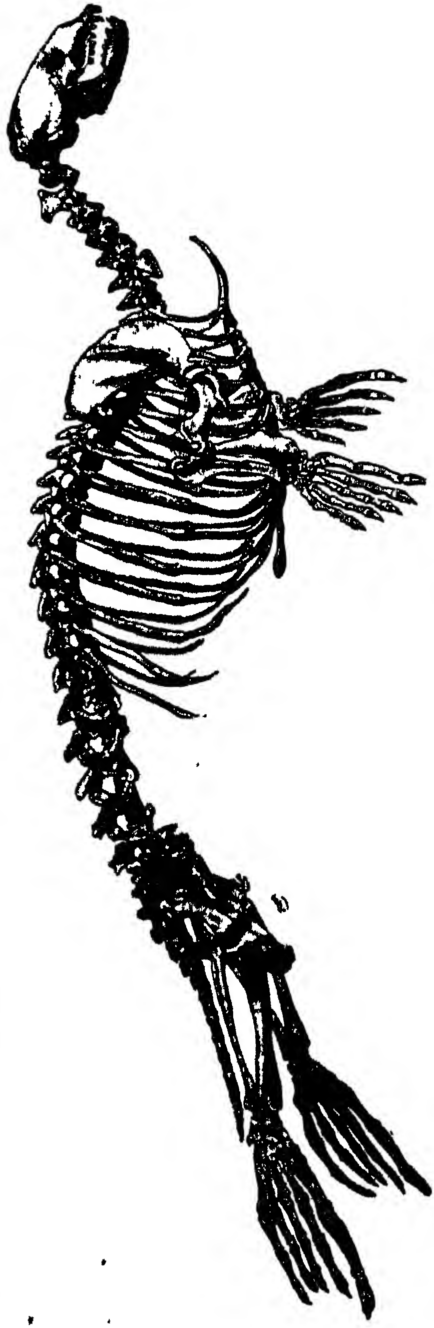


FIG. 227.—Skeleton of Seal. *Phoca vitulina.* (After de Blainville.)

six, and the additional molar was at the end of the series, thus suggesting a lengthening of jaw coupled with an increase in number of teeth.

The incisor teeth of the Pinnipedia differ from those of the land Carnivora in that there are nearly always fewer than $\frac{3}{3}$, at least in the adult animal. In possessing lobulated kidneys the Pinnipedia differ from all terrestrial Carnivores except the Otters and Bears—a significant fact.

In the characters of the skeleton the Pinnipedia show many peculiarities. The cranial part of the skull is proportionately to the facial part greater than in terrestrial Carnivora; there is no lachrymal bone, and the orbit is to some extent defective in ossification. The alisphenoid canal, so important a feature in the Carnivora, may be present or absent. It is present, for example, in *Otaria jubata*.[1] This genus also has the more

FIG. 228.—Patagonian Sea-Lion. *Otaria jubata.* × $\frac{1}{15}$.

primitive small and rugged tympanic bullae, which are inflated and more Cat-like in others. The vertebrae show an interesting Creodont peculiarity in the complex interlocking arrangements of the zygapophyses of the dorsal vertebrae. The ossicula auditus differ from those of their terrestrial allies in their large size and massive growth. In this they have come to be like those of the Whales and Sirenians.

There is no doubt about their close resemblance to the

[1] Murie, *Trans Zool. Soc.* viii. 1874, p. 501.

terrestrial Carnivora, but the question is, to which group of Carnivora have they the most likeness. The semiaquatic Otter, and the still more thoroughly aquatic (marine) *Enhydris*, suggest an affinity in that direction. The long body and short legs of the Otter, which is more thoroughly at home pursuing fish in the streams than in waddling clumsily upon the banks of the streams, seem to require but little external change to convert it into a small Seal, while the long and completely webbed hind digits of *Enhydris* are even more like those of a Pinniped. The Sea-Lions, in which the external ear has been preserved, and in which the limbs have not become so entirely useless for progression on the land as they have in the Seals, seem to be the intermediate step in the evolution of the latter. This, however, is not the opinion of Dr. Mivart, who, without definitely committing himself on the point, presents some evidence for the assumption that the marine Carnivora are diphyletic. This double origin, however, is not from two groups of the terrestrial Carnivora. Dr. Mivart, in common with many others, holds that the Pinnipedia as a whole are undoubtedly nearer to the Arctoidea than to either of the two remaining sections of the sub-order. One of the most striking structural characters in which they show this resemblance is the brain; the peculiar Ursine lozenge, already treated of as so distinctive a character of the Arctoidea, is repeated in the Pinnipedia.

There are, however, other points of likeness which seem rather to point to a Creodont origin. *Patriofelis* is a genus that from more than one side may be looked upon as a possible ancestor of these animals. The Creodont peculiarity of the vertebrae has already been referred to. It may be added that the facial part of the skull is small in *Patriofelis*, which appears, moreover, to have had an alisphenoid canal. A very remarkable resemblance lies in the structure of the astragalus. This is not deeply grooved on the tibial facet as it is in Fissiped Carnivora. This might be held to be an instance of degeneration in the aquatic Seals, which do not use their limbs as walking organs. But Professor Wortman [1] has pointed out that in the Sea-Otter, which is entirely aquatic, the groove exists and is plain. The likeness offered to the Seals by the spreading feet of *Patriofelis* is noticed under the description of that genus.[2]

[1] *Bull. Amer. Mus. Nat. Hist.* vi. 1894, p. 129. [2] P. 456 below.

Fam. 1. Otariidae.—The family Otariidae[1] is no doubt the least modified of the aquatic Carnivora. It is rational, therefore, to commence the survey of the group with this family. They have preserved, as already noted, the independence of the hind-limbs; the external ear is present, though small, there is an obvious neck, and the nostrils are at the end of the snout, as in

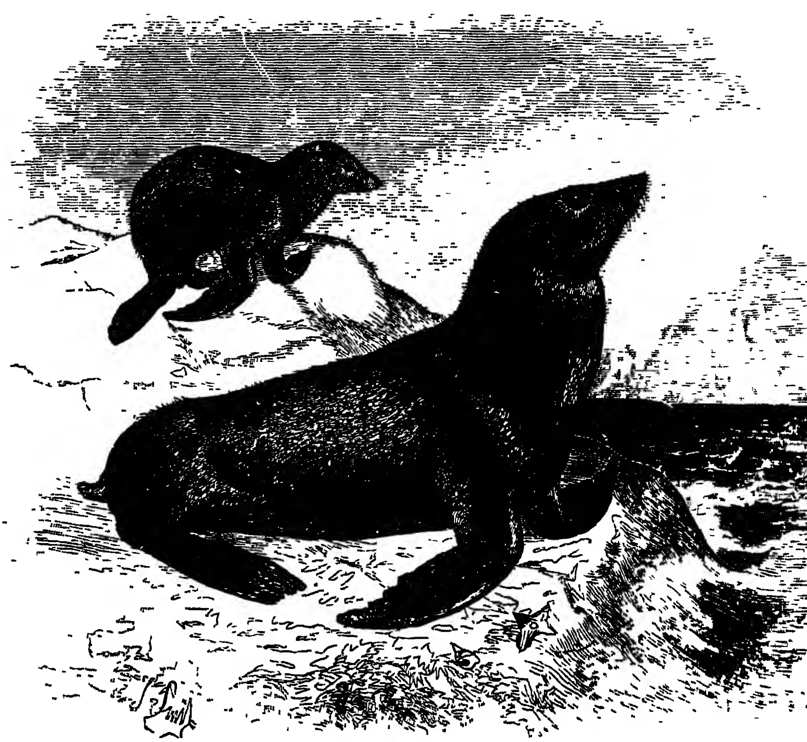


FIG. 229.—Cape Sea-Lion. *Otaria pusilla*. × $\frac{1}{16}$.

terrestrial creatures generally. The nails are small and rudimentary, save those upon the three middle digits of the foot. It is a singular fact that among the Otaries the angle of the lower jaw is "inflected as much as in any Marsupial." The literature relating to this family is great, and it seems difficult to reconcile the very varying opinions as to how many genera ought to be admitted. Mr. Allen arranged the nine species which he allowed

[1] See especially Allen, *North American Pinnipedes*, 1880.

in six genera, but more generic names have been proposed. At the other extreme stands Dr. Mivart, who speaks of only one genus, *Otaria*; of this genus the number of species is by no means agreed upon. There can, however, be no doubt of the distinctness of the Northern Fur Seal, *O. ursina* (the "Seal" of commerce and the cause of international complications), of the Patagonian Maned Sea-Lion, *O. jubata*,[1] of *O. pusilla* of the Cape, of the Californian *O. gillespiei*, of *O. hookeri* from the Auckland Islands, and of four or five others. The range of the genus is wide, but is mainly Antarctic. It is usual to speak of "Hair Seals" and "Fur Seals," the latter being the species which produce the "sealskin" of commerce. The difference is that in the Fur Seals there is a dense, soft under-fur, which is wanting in the other group. It is, however, impossible to make this character the basis of a generic subdivision. There is a Fur Seal, *O. nigrescens*, in South America as well as the more widely-known northern form.

Fam. 2. Trichechidae.—This family contains but one genus, *Trichechus*, the Walrus or Morse, or *Odobaenus*, as the more correct term seems to be. It is a tiresome result of accurate conformity with the rules of priority in nomenclature that the name *Trichechus* should be applied to the Manatee. There is but one species of Walrus, though it has been attempted to show that the Pacific and Eastern forms are different. The animal is Arctic and circumpolar. The Walrus is characterised by the enormous canines of its upper jaw, which form the well-known tusks and reach a length of 30 inches. The animal can progress on land like the Sea-Lions; but, as in the Seals, there are no external ears, though there is a slight protuberance above the meatus auditorius. The strong bristles upon the upper lip are as thick as crow quills. The pectoral limb has nails, but these are small, as in the Sea-Lions. The under surface of the manus has a warty pad, which cannot but assist[2] in maintaining a foothold upon slippery ice. The hind-limbs have longer nails, which are still diminutive and subequal in size. There is no free tail. The liver of this animal is much furrowed, but not so much so as in *Otaria*, though more so than in *Phoca*. The kidneys are of course lobulate, as in the other aquatic Carnivores. The milk dental formula appears to be I $\frac{3}{3}$ C $\frac{1}{1}$ Pm + M $\frac{5}{4}$. In the adult the formula[3] is I $\frac{1}{0}$ C $\frac{1}{1}$ M $\frac{3}{3}$.

[1] Murie, *Trans. Zool. Soc.* vii. 1894, p. 411.

[2] Cf. the Dugong, p. 336.

[3] Kukenthal, *Jen. Zeitschr.* xxviii. 1894, p. 76.

Fam. 3. Phocidae.—The true Seals have no external ears, and the nostrils are quite dorsal in position as in other aquatic animals, such as the Crocodile. There is obviously an approach to the conditions characteristic of the Whales. The hind-limbs are useless for locomotion on land. They are bound up with the tail, and form functionally merely a part of the tail. In this family there are, at any rate, eight genera.

Phoca and *Halichoerus* are not very wide apart from each other. In both there are five well-developed claws on feet and hands. They are British, and generally Arctic and temperate in range. For some reason or other the late Dr. Gray placed *Halichoerus* in the same sub-family with the Walrus! *Phoca* is

FIG. 230 —Common Seal. *Phoca vitulina.* × ⅛. (From Parker and Haswell's *Zoology*)

not only marine, but is found in the Caspian and in Lake Baikal. Their existence in those inland seas is believed to be a vestige of a former connexion with the sea. *Halichoerus grypus* is a large seal 8 feet in length when full grown. Its colour is yellowish grey, with darker grey spots and blotches. It is not uncommon on the shores of our islands, particularly of the Hebrides and Argyllshire. The commonest Seal is *Phoca vitulina*, not more than 4 to 5 feet long, and of the same spotted coloration as the last. This Seal has, however, a much wider distribution, being Arctic as well as British, American, and North Pacific. A curious fact about this Seal is that it is not impatient of fresh water; not only will it ascend rivers, but it will live in inland lakes. It is said to be especially sensitive to musical sounds. *P. hispida* is British, but a rare visitor to our islands. It is essentially an Arctic species. The Harp Seal, *P. groenlandica*, is so called on account of a harp-shaped black bar in the males, which starts at

the shoulders and extends to the thighs. Like the other Seals mentioned, the young are white when first born. As may be inferred from its scientific name this species is also Arctic in range. It is also a rare visitor to these shores.

The genus *Cystophora* is the only other genus of which there is a British representative. It is called the Hooded Seal on account of an inflatable sac upon the face, with which it is said to attempt to terrify its enemies. The genus has an incisor less in each half of each jaw than *Phoca* and *Halichoerus*. Its formula is I $\frac{2}{1}$ while these genera are both $\frac{3}{2}$. *C. cristata* is a large species reaching a length of 10 feet. The colour of the back is dark grey with deeper coloured spots. A few individuals only have been recorded from our coasts.

Stenorhynchus (= *Ogmorhinus*) is an Antarctic genus. The hind-feet are clawless. The incisors are $\frac{2}{2}$. The molars have an additional cusp, *i.e.* three in all.

The genus *Leptonyx* with but one species, *L. weddelli*, is purely Antarctic in range. Like the last genus it has two incisors, and has but rudimentary claws upon the hind-feet; the first and fifth toes moreover are the longest. The genus chiefly differs from the last in the simple conical crowns of the molars, which have not the additional cusps of *Stenorhynchus*.

Ommatophoca is another Antarctic genus with but a single species, *O. rossi*. In this genus the hind-feet have no claws, and the first and fifth toes are longer than the others. The claws of the fore-feet are rudimentary. The immense size of the orbits gives the name to the genus. There are two incisors, and the molars are all very small.

Monachus is a northern genus inhabiting the Mediterranean and the Atlantic in the vicinity of Madeira and the Canary Islands. It has rudimentary nails upon both pairs of feet. The first and fifth toe of the hind-feet are longer than the others. As with the preceding genera, the incisors are two in each jaw. The species are *M. albiventer*, the Monk-Seal, and *M. tropicalis*, the Jamaica Seal.

Allied to *Cystophora* is the genus *Macrorhinus*, with (possibly) two species, of which one is Antarctic, the other frequents or frequented the coast of California. The incisors are two in the upper jaw, and but one in the lower. The premolars are four and the molar one; all the teeth are small and simple, but

have long roots. The nose of the male has a dilatable proboscis. The southern Elephant Seal is *M. leoninus*, and reaches a length of some 20 feet. It occurs on the shores of Kerguelen and some other more or less remote islands. Its habits have been studied and described by several observers, beginning with Anson in the last century. The late Professor Moseley gave a good account of this marine monster in his book on the voyage of the "Challenger." When the animal is enraged, the end of the snout is dilated; but when this happens there is no long and hanging proboscis such as has sometimes been described. The inflation affects the skin on the top of the snout, which thus rises rather upwards during inflation. The inflated region, according to Mr. Vallentin, quoted by Mr. J. T. Cunningham, is about 1 foot long in an individual of 17 feet. It has been stated that this proboscis is a temporary structure, only appearing in the breeding season; but recent observations have shown that this statement is inaccurate; it persists all the year round. The males fight greatly during the breeding season, and produce a roar which has been compared to the "noise made by a man when gargling." The females and the young males bellow like a bull. The males fight of course with their teeth, literally falling upon one another with their whole weight. Mr. Cunningham thinks that the use of the proboscis is to protect the nose from injury; or that it may be merely the result of "emotional excitement." In any case the Bladder-nosed Seal, *Cystophora*, is undoubtedly protected from injury by the possession of a corresponding hood. The nose is the most vulnerable place, and the existence of this hood would stave off the effects of a blow in that region. Moseley, however, has said of *Macrorhinus* that it cannot be stunned by blows on the nose as other Seals can; but he attributes this, not to the dilated snout, but to the bony crest on the skull, and to the strength of the bones about the nose. This Seal crawls with difficulty on the land, and as the animals move "the vast body trembles like a great bag of jelly, owing to the mass of blubber by which the whole animal is invested, and which is as thick as it is in a whale."[1] When lying on the shore, these animals scrape sand and throw it over themselves, apparently to prevent themselves from being

[1] Cunningham, "Sexual Dimorphism in the Animal Kingdom," London, 1900; see also Flower, *Proc. Zool. Soc.* 1881, p. 145.

incommoded by the direct rays of the sun, to the effects of which they are very susceptible. The Elephant Seal is mild and inoffensive, unless enraged, and, of course, during the breeding season.

Order VIII. CREODONTA.

This entirely extinct group of Mammalia may be thus characterised:—Small to large carnivorous mammals, with skull on the whole like that of the Carnivora and with trenchant teeth; digits with unguiculate phalanges; tail long; extremities usually with five, sometimes with four digits. In the carpus a centrale is present, and the scaphoid and lunar are separate. Interlocking of posterior dorsal and lumbar zygapophyses very perfect. Brain small but convoluted.

This group, which corresponds with the CARNIVORA PRIMIGENIA of Mr. Lydekker, is not easy to separate absolutely from the existing and more especially from some of the extinct members of the CARNIVORA VERA. They also come exceedingly near the Condylarthra, the presumed ancestors of the Ungulata, and like them begin in the earliest Tertiary deposits. Their likeness to the carnivorous Marsupials has also been insisted upon; but it would seem that the succession of teeth in the Creodonta is typically Eutherian.

The characteristics of the group may be exemplified by an account of the genus *Hyaenodon*, after which some of the more important deviations in structure shown by other genera will be referred to.

Hyaenodon is both American and European, and ranges through the Eocene and the Upper Miocene. It is a much-specialised Creodont, and therefore exhibits well the distinctive characters of the group. About a dozen species have been described. One of the best-known is the American *H. cruentus*, and the following description refers to it. The back part of the skull is low and broad, and is compared by Professor Scott (who has described this and other species) as being "somewhat like that of an opossum."[1] The whole skull is

[1] *Journ. Ac. Sci. Philadelphia*, ix. 1886, p. 175.

long, and the top has a great sagittal crest. The paroccipital processes are short and are closely applied to the mastoid processes. The mesethmoid is larger than in the carnivorous Marsupials, and the frontals are very large. The palate has a peculiar structure; in most species the hinder ends of the palatines are separated by a narrow fissure which broadens gradually, thus forming the posterior nares. In *H. leptocephalus* the posterior nares are brought very far back by the meeting of the alisphenoids. The presphenoid, contrary to what we find in the Dog, for example, is chiefly concealed by the vomer, which covers it. The mandible has a long and strong symphysis, and its angle is not inflected. The fore-limb is described as being "weak when compared with the modern Carnivora." The scaphoid and lunar are separate, and there is a centrale. The teeth present us with nearly the typical formula. There is only one molar missing in the upper jaw. The canines are enlarged. It has been suggested from a consideration of its palate that *Hyaenodon* was a semiaquatic animal; the deep cleaving at the extremities of the phalanges seems to point in the same direction, since they resemble in this the genus *Patriofelis*, which there are other reasons to regard as aquatic. This latter genus has a fore-limb which is very like that of the Pinnipedia, the digits are much spread out, and would seem to have supported a kind of paddle. In any case it certainly fed upon aquatic tortoises, for their remains have been found in its coprolites. The name *Limnofelis*, also applied to what appear to have been members of this genus, is suggestive of their habits. *Patriofelis*, at least one species, seems to have been of about the size of a Lion.

Mesonyx has a brain case which is actually smaller than that of the Marsupial *Thylacinus*. The lachrymal bone is very large, and extends a little way over the face, as is also the case with *Hyaenodon;* this condition is also found in Insectivora and in *Thylacinus*. The axis vertebra has a curiously-shaped spine, which is very different from the hatchet-shaped process of that vertebra usual in the Carnivora, but is not unlike what exists in the Arctoid genera *Meles* and *Mydaus*. The limbs show much disparity in length, and seem to argue a much-arched back when the creature progressed. The carpus is stated to be strikingly like that of the Insectivora. There is as in other Creodonts a separation between the scaphoid and lunar;

the centrale appears to be present. The pelvis "is most like that of the bear," the metacarpals and the tibia, and some other bones, resemble those of the Hyaena. In fact this animal shows those combined characters which are common in archaic forms.

CHAPTER XV

RODENTIA—TILLODONTIA

Order IX. RODENTIA[1]

SMALL to moderately large animals, furry, sometimes with spines. Toes with nails of a claw-like character, or sometimes approaching hoofs. Usually plantigrade, and only occasionally and partly carnivorous. Canine teeth absent; incisors long and strong, growing from persistent pulps, and with enamel only or chiefly on the anterior face, producing a chisel-shaped edge; molars few (two to six), separated from the incisors by a wide diastema. Caecum (nearly always present) very large, and often complicated in structure. Brain, if not smooth, with few furrows, the hemispheres not overlapping the cerebellum. Surface of skull rather flat; orbits not separated from temporal fossae; malar bone in middle of zygomatic arch, palate very narrow, with elongated incisive foramina, articular surface for lower jaw antero-posteriorly elongated. Clavicles generally present. Testes generally abdominal. Placenta deciduate, and discoidal in form.

The Rodents are a very large assemblage of usually small, sometimes quite minute, creatures, embracing an enormous number of living generic types. They are distributed all over the world, including the Australian region, and, being small and often nocturnal, and by no means particular in their diet, have managed to thrive and multiply to a greater extent than any other group of living mammals. They are chiefly terrestrial creatures, and often burrow or live in ready-made burrows.

[1] See especially Tullberg, "Ueber das System der Nagethiere," *Act. Ak. Upsala*, 1899; and Alston, *Proc. Zool. Soc.* 1875, p. 61; and for nomenclature, Thomas, *Proc. Zool. Soc.* 1896, p. 1012, and Palmer, *Proc Biol Soc. Washington*, xi, 1897, p. 241.

Some, however, such as the Voles, are aquatic; others, *e.g.* the Squirrels, are arboreal, and there are "flying" Rodents exemplified by the genus *Anomalurus*. Their range of habitat is in fact as wide as that of any other Order of mammals, and wider than that of most.

The most distinct anatomical characteristic of the Rodents concerns the teeth. They are without exception entirely deprived of canines. Thus there is a long diastema between the incisors and the molars. Another peculiarity is, that in many cases the dentition is absolutely monophyodont. In such forms as the Muridae there seems to be no milk dentition at all. In that family there are only three molars; but in other types where there are four, five, or six molars, the first one, two, or three, as the case may be, have milk predecessors, and may thus be termed premolars. This has been definitely proved to be the case in the common Rabbit, which has the unusually large number of six grinding teeth in each half of the upper jaw when adult. The first three of these have milk forerunners. On the other hand the existence of four molars does not apparently always argue that the first is a premolar; for Sir W. Flower found that in *Hydrochoerus*,[1] none of the teeth had any forerunners, at any rate so far as could be detected from the examination of a very young animal. The Rabbit appears to be also exceptional, in that the second incisor of the upper jaw and the incisor of the lower jaw have milk forerunners. In any case the tendency towards monophyodontism is peculiarly well-marked in this group of mammals. The incisors of Rodents are as a rule in each jaw a single pair of long and strong teeth, which grow from persistent pulps, and

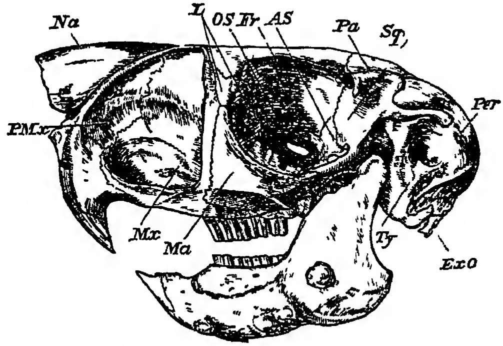


FIG. 231.—Side view of skull of Cape Jumping Hare (*Pedetes caffer*). × ⅘. *AS*, Alisphenoid; *Ex.O*, exoccipital; *Fr*, frontal; *L*, lachrymal; *Ma*, malar; *Mx*, maxilla; *Na*, nasal; *OS*, orbitosphenoid; *Pa*, parietal; *Per* points to the large supratympanic or mastoid bulla; *PMx*, premaxilla; *Sq*, squamosal; *Ty*, tympanic. (From Flower's *Osteology*.)

[1] *Proc. Zool. Soc.* 1884, p. 252.

grow to a very great length, extending back within the jaw to near the hinder part of the skull. These teeth are reinforced in the upper jaw by a small second pair in the Lagomorpha only. The incisors are chisel-shaped, and often brown or yellow upon the outer face, as is the case also with some Insectivores. This peculiar shape, and their strength, renders them especially capable of the gnawing action which characterises the Rodents. It has been pointed out that where the incisors are wider than thick, the gnawing powers are feebly developed; and that on the contrary, where these teeth are thicker than wide, the animals are good gnawers. The incisors have often an anterior groove, or it may be grooves.

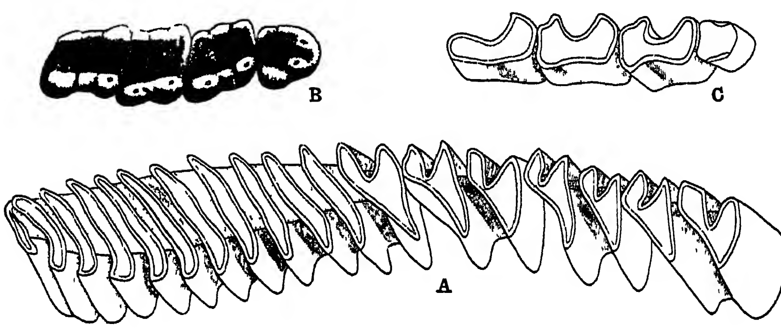


FIG. 232.—Molar teeth of Rodents. A, of Capybara (*Hydrochoerus*); B, of Squirrel (*Sciurus*), C, of *Ctenodactylus*. (After Tullberg.)

The cheek teeth vary in number from two (*Hydromys*) to six (Rabbit) on each side of the two jaws. Four is the prevailing number outside the large division of the Rat-like Rodents. They are often set at an angle to the horizontal plane of the jaw, looking outwards and obliquely to its longitudinal axis; the individual teeth too are not unfrequently bowed in form, reminding us of those of *Toxodon*. This of course only occurs in those genera which have hypselodont teeth. The pattern of the teeth varies much, and the different forms recall the teeth of more than one other group of mammals. They are either bunodont or lophodont. In many cases the tooth is encircled with a ridge of enamel, which is either almost simple or has a more complicated contour; such teeth are by no means unsuggestive of the Toxodonts. Some of the lophodont molars are by no means unlike those of the Proboscidea. In *Sciurus vulgaris* the

encircling ridge is broken up into tubercles, which gives to the tooth a striking likeness to those of *Ornithorhynchus*. Other genera have teeth like those of many Ungulates. It has been shown by Sir J. Tomes[1] that the minute structure of the enamel differs in different groups of Rodents.

The skull shows certain primitive characters. In the first place there is no distinction between the orbital and the temporal fossa.[2] The sutures between the bones retain their distinctness for very long. Other characteristic features are the following:— The nasals are large, and so are the paroccipital processes. The palate in front of the molars is not distinct from the sides of the skull, its edge gradually becoming rounded off above. It is also very narrow. The premaxillae are large in relation to the great incisors. There is often a very much enlarged infra-orbital foramen through which passes a part of the masseter muscle. The jugal bone lies in the middle of the zygomatic arch, which is complete and enormously enlarged in the Spotted Cavy (*Coelogenys paca*). As in many Marsupials, the jugal bone sometimes extends backwards to the glenoid cavity, where the lower jaw articulates. It is usually said with an absolute want of accuracy that the cerebral hemispheres of the Rodents are smooth and without convolutions. This error has been repeated again and again in text-books. As a matter of fact the cerebral hemispheres of many forms are quite well convoluted,[3] the degree of furrowing corresponding, as in so many groups of mammals, with the size of the animal. This at any rate is generally true, though the large Beaver with its scant convolutions is an exception. The smaller forms, such as *Mus*, *Sciurus*, *Dipus*, and *Cricetus* are quite smooth-brained. The best furrowed brain of any Rodent which has been examined is that of the huge *Hydrochoerus*. The Sylvian fissure is very generally not pronounced; but is particularly well-marked in *Lagostomus*. In all, or in most, Rodents the hemispheres are separated by an interval from the cerebellum, the optic lobes being visible between the two.

The mouth cavity of this group of mammals is divided into two chambers by a hairy ingrowth behind the incisors; this arrangement is useful for animals which use their strong incisors

[1] *Phil. Trans.* 1850, pt. ii. p. 529. [2] Seen, however, in *Chaetomys*.

[3] See Beddard, *Proc. Zool. Soc.* 1892, p. 596, and Gervais, *Journ. Zool.* i. 1872, p. 450.

postorbital processes. The infra-orbital foramen is, as a rule, not large, but is increased in size in a few forms. The number of separate pieces of bone in the sternum is five. The molars of the upper jaw are five, but the first is very small and soon drops out.

The Squirrels are often rather brilliantly coloured. The Chinese *Sc. castaneiventris* has grey fur with a rich chestnut-coloured under surface. The Malabar Squirrel, *Sc. maximus*, as its name implies, a large animal, has a deep reddish or chestnut-coloured fur above, which becomes yellow below. The "Common Squirrel," "the lytill squerell full of besynesse," which is the Squirrel of this country, is brownish red on the upper parts and white below. It ranges from this country as far east as Japan. Like many other Rodents the Squirrel likes animal food and will eat both eggs and young birds. "Camel's hair" brushes are made from this animal. The genus *Tamias*, almost exclusively North American in range, is included by Dr. Forsyth Major[1] in this genus, which then consists of considerably over one hundred species.

The Ethiopian Ground Squirrels, genus *Xerus*, have a more elongated skull than *Sciurus*, and the postorbital processes are shorter. The feet are not hairy.

Nannosciurus forms a perfectly distinct genus of Squirrels. These "Pygmy Squirrels" differ in possessing a very elongated "face" and in the very broad frontal region. The teeth are unlike those of *Sciurus* in certain features, and have been especially compared by Forsyth Major to those of the Dormice. Four species of this genus are Malayan; one is West African.

The Bornean *Rheithrosciurus macrotis* is the only species of its genus. The genus may be distinguished by the exceedingly brachyodont molars, this feature being more marked in this genus than in all other Squirrels. It is called the "Groove-toothed Squirrel," from the "seven to ten minute parallel vertical grooves running down the front face of its incisors."[2]

The genus *Spermophilus* includes a large number (forty or so) of Palaearctic and Nearctic animals known as Sousliks. The ears are small; there are cheek pouches as in *Tamias*. The general aspect of the animal is like that of a Marmot, and they bridge over the exceedingly narrow gap which separates the Marmots from the true Squirrels. Anatomically the skull is like that of

[1] *Proc. Zool. Soc.* 1893, p. 179 [2] Flower and Lydekker.

Arctomys; the molars are five in the upper and four in the lower jaw. The caecum is relatively speaking very small; the measurements in a specimen of *S. tredecimlineatus*, dissected by Dr. Tullberg, were: small intestine, 580 mm; large intestine, 170 mm.; and caecum, 27 mm. In *Tamias* also the caecum is not greatly developed. These animals are burrowing in habit.

The Prairie-dogs, genus *Cynomys*, of which the best-known species is perhaps *C. ludovicianus*, are very like the Squirrels, but they are not arboreal creatures; they live in burrows on the ground, as their vernacular name denotes. The genus is entirely North American, and four species have been differentiated.

The Prairie-dog or Prairie-marmot is some 10 inches to one

FIG. 233 —Long-tailed Marmot. *Arctomys caudatus.* × ⅐.

foot in length. The tail is no more than 2 inches. The ears are very small; the thumb is fully developed and bears a claw. The measurements of the various sections of the intestine are the following:—Small intestine, 860 mm.; large intestine, 690 mm.; caecum, 75 mm. Thus the caecum is not large comparatively speaking. These animals dig burrows on grassy plains which they share with the Ground Owl (*Speotyto cunicularis*) and with Rattlesnakes, all three species appearing to live in perfect amity. Probably the Owls use the conveniently-constructed burrows, and the Rattlesnakes come there to look after the young of both.

Closely allied to the last are the Marmots, genus *Arctomys.* They differ in the rudimentary character of the thumb and in the longer tail. The eyes and ears are small. The distribution of the genus is Nearctic and Palaearctic. There are ten species of

the genus. The Alpine Marmot, *A. marmotta*, is familiar to most persons. The animal lives high up in the Alps, and when danger threatens it gives vent to a shrill whistle. It hibernates in the winter, and as many as ten to fifteen animals may be found closely packed together in a single, carefully-lined burrow.

The only other European species is *A. bobac*, the Siberian Marmot, which occurs in the extreme east of Europe, and is also Asiatic. There are four North American species, including the Quebec Marmot, *A. monax*.

The genus *Pteromys* (of which the proper name, antedating

FIG. 234 —Flying Squirrel *Pteromys alborufus*. × ⅛.

Pteromys by five years, appears to be *Petaurista*) is confined to the Oriental region, where there are a dozen species or so. The limbs are united by a parachute extending to the toes, and supported anteriorly by a cartilage attached to the wrists. There are also membranes anteriorly uniting the fore-limbs to the neck, and posteriorly uniting the hind-limbs to the root of the tail and a trifle beyond. The skull and the dental formula are as in *Sciurus*, but the pattern of the molars, which is much complicated, seems to argue a different mode of nutrition. There are twelve pairs of ribs. The large intestine (in *P. petaurista*) is very nearly as long as the small, and the caecum is also "colossal"; the measurements in an individual of the species named were: small intestine, 670 mm.; caecum, 320 mm.; large intestine, 650 mm.

The caecum is disposed in a spiral. The teats are three pairs, non-inguinal in position.

The size of these squirrels is 16 to 18 inches exclusive of the tail, which is longer. These animals can make an exceedingly long jump with the help of their flying membrane. Nearly eighty yards is the longest distance given for these aerial excursions. It is stated that they are able to steer themselves to some extent while in the air. As appears to be the case with so many Rodents, these animals feed largely upon beetles and other insects, besides bark, nuts, etc.

The allied genus *Sciuropterus* has a much wider range. It extends into the Palaearctic region and into North America, besides being found in India. There is here no membrane reaching to the tail. The palms and soles are furry. The caecum is very much shorter, and so is the large intestine. The latter, in *S. volucella*, is not more than one-third of the length of the small intestine. In other features there are no remarkable differences in structure, save that the mammae, always three pairs, may be inguinal.

Of the genus *Eupetaurus*[1] but a single species is known, which is limited to high altitudes at Gilgit and perhaps in Thibet. Its principal difference from the other genera of Flying Squirrels is that the molars are hypselodont instead of brachyodont. The interfemoral membrane is rudimentary or wanting. The one species is *E. cinereus*. It is thought to live "on rocks, perhaps among precipices." Dr. Tullberg attributes the hypselodont teeth to the fact that the mosses upon which it is believed to feed may have much sand and earth intermingled, which would naturally lead to a more rapid wearing away of the teeth, and hence a need for a good supply of dental tissue to meet this destruction.

Fam. 3. Castoridae.—This, the third family of the Sciuromorpha, contains but one genus, *Castor*, the Beaver, with at most two species, one North American, the other European. This large Rodent has small eyes and ears, as befits an aquatic animal, and the tail is exceedingly broad and covered with scales; the transverse processes of the caudal vertebrae, in order better to support the thick tissues lying outside them, are divided in the middle of the series into two. The hind-feet are much larger than the fore-feet, and are more webbed than in any other aquatic Rodent.

[1] Thomas, *J. Asiat. Soc. Bengal*, lvii. 1888, p. 256.

In the skull the infraorbital foramen is small as in Squirrels. The postorbital process has practically vanished. The four molars stand out laterally from the jaws. The incisors, as might be surmised from the habits, are particularly strong. The stomach has near the entrance of the oesophagus a glandular patch, which seems to be like that of the Wombat (see p. 144). In both sexes the cloaca is very distinct and comparatively deep.

The two species of the genus are *C. canadensis* and *C. fiber*. The latter is of course the European species, which is now found in several of the large rivers of Europe, such as the Danube and the Rhone. But it is everywhere getting scarce, and limited to quite small and isolated colonies.

In this country it is absolutely extinct and has been since before the historic period. There is apparently no documentary evidence of its survival down to this period. But the numerous names of places which are called from this animal illustrate its former prevalence. Examples of such names are Beverley in Yorkshire, and Barbourne or Beaverbourne in Worcestershire. In Wales, however, Beavers seem to have persisted longer. But they were rare in the Principality for a hundred years or so before the Norman Conquest. The king Howel Dda, who died in 948 A.D., fixed the price of a Beaver skin at 120 pence, the skins of Stag, Wolf, and Fox being worth only 8 pence apiece. The Beaver was called by the Welsh "Llost-llyddan," which means "broad-tail." Its existence in the country is handed down in the name of Llyn-ar-afange, which means Beaver lake. The last positive record of the Beaver in Wales seems to be the statement of Giraldus Cambrensis that in 1188 the animal was still to be found in the river Teivy in Cardiganshire. In Scotland the Beaver is said to have continued down to a later date. Ireland it never reached. The remains of this animal by their abundance show the former prevalence of *C. fiber* in this country. It is known from the fens of Cambridgeshire, and from superficial deposits elsewhere. The Thames formerly had its Beavers, and apparently it was widely spread through the country generally.

The Beaver not only furnishes collars and cuffs for coats; it was used, as every one knows, to provide hats. But the usefulness of the animal by no means ended here in the eyes of our

forefathers. The Rev. Edward Topsell observed that "for giving great ease unto the gowt the skinnes of beavers burned with drie oynions" are excellent. Castorein as a drug, if not in actual use, has quite recently been a part of the pharmacopoeia. It is derived from the anal glands common to this and other Rodents, and indeed many other mammals.

A large extinct form of Beaver is *Trogontherium*,[1] found in the "Forest-bed" of Cromer. The skull is about one-fourth longer than that of *Castor*. It has a less inflated bulla, and slightly more pronounced postorbital processes than *Castor*. The third molar (fourth grinding tooth) is relatively larger than in *Castor*, and has a rather more folded crown. The foramen magnum is more triangular.

Fam. 4. Haplodontidae.—A separate family seems to be required for the genus *Haplodon*, whose characters will therefore be merged with those of its family. It is to be distinguished from most other Squirrel-like creatures by the fact that there is no postorbital process to the frontal. The molar teeth are five in the upper and four in the lower jaw. The Sewellel, *H. rufus*, like the other species of the genus (*H. major*), is found in North America west of the Rocky Mountains. It has the habit of the Prairie-marmot, and has a short tail, only moderately long ears, and five-toed feet. Tullberg is of opinion that this animal nearly represents the ancestral form of the Squirrel tribe.

SECTION 2. MYOMORPHA.

This subdivision of the Rodents contains, according to Mr. Thomas's recent estimate,[2] no less than 102 genera. It is therefore obviously impossible to do more than refer to some of the more interesting of these. This group is again divided into the following families:—

(1) Gliridae, including the Dormice.

(2) Muridae, the Rats, Mice, Gerbilles, Australian Water-rats, Hamster.

(3) Bathyergidae, Cape Mole, etc.

(4) Spalacidae, Bamboo Rats.

[1] E. T. Newton, *Trans. Zool. Soc.* xiii. 1892, p. 165.

[2] *Proc. Zool. Soc.* 1896, p 1016.

(5) Geomyidae, Pouched Rats.
(6) Heteromyidae, Kangaroo Rats.
(7) Dipodidae, Jerboas
(8) Pedetidae.

The Gliridae have no caecum, so usual in the Rodentia. It is true that all the genera have not been dissected, but it is known that in the true Dormice, as well as in the genus *Platacanthomys*, a caecum is absent.

Apart from these few exceptions the Mouse-like Rodents all possess a caecum, though it is often not very large. They are all smallish animals, and are modified to a great variety of habit and habitat. There are burrowing, swimming, and climbing forms. The group is universal in range, even including the Australian region, in which they are the only Rodents.

Fam. 1. Gliridae.—This family, also called Myoxidae,[1] includes the Dormice, and is entirely an Old-World family, absent only from the Malagasy region. Its most important differential character is the total absence of the caecum and of any sharp boundary between the small and large intestine. The molars are usually four. The eyes and ears are well developed.

The genus *Muscardinus* includes only the Common Dormouse, *M. avellanarius*. This small creature, 3 inches long with a tail of 2½ inches, is, of course, a well-known inhabitant of this country. It is also found all over Europe. It is not particularly abundant in this country, and a good specimen is said to be worth half a guinea. As the specific name denotes, it lives largely on hazel nuts; but it will also suck eggs and devour insects. The animal makes a "nest" in the form of a hollow ball. Its hibernation is well known, and has also given rise to the German name ("Schläfer") of the group. It was well known to Aristotle, who gave or adopted the name Ἐλειὸς for the animal. Its winter sleep—suggestive of death—and its revivification in the spring gave the Bishop of Salamis, Epiphanius, an argument for the resurrection of man. The fur was reckoned in Pliny's time a remedy for paralysis and also for disease of the ears.

The genus *Myoxus* includes also but a single species, *M. glis*, the so-called "Fat Dormouse" of the Continent. It has no

[1] Reuvens, "Die Myoxidae oder Schläfer," Leyden, 1890, allows but one genus, *Myoxus*, the other genera adopted here being termed subgenera.

glandular swelling at the base of the oesophagus, such as occurs in the last genus and in *Graphiurus*. Of *Graphiurus* there are thirteen species, all African in range. The genus does not differ widely from the last. There is, however, a glandular region of the oesophagus. *Eliomys* is the last genus of typical Dormice. It is Palaearctic in range.

Platacanthomys, of a Dormouse-like form, has like other Dormice a long tail, on which the long coarse hairs are arranged in two rows on opposite sides towards the tip; it is represented by a single species, *P. lasiurus*, from the Malabar coast. It is arboreal in habit. The fur is mingled with flattened spines. The molars are reduced to three on each side of each jaw. This form has been bandied about between the "Mice" and the "Dormice"; but Mr. Thomas's discovery of the absence of the caecum argues strongly in favour of its correct location among the Gliridae. *Typhlomys* is an allied genus, also from the Oriental region. This and the last are placed in a special sub-family of the Gliridae, Platacanthomyinae, by Mr. Thomas.

Fam. 2. Muridae.—This family, that of the Rats and Mice in a wide sense, is the most extensive family of Rodents. In it Mr. Thomas includes no less than seventy-six genera. The molars are generally three. The tail is fairly long, or very long, and the soles of the feet are naked.

Sub-Fam. 1. Murinae.—The true Rats and Mice may be considered to form a sub-family, Murinae. The genus *Mus*, including the Rats and Mice in the limited sense of the word, contains about 130 species. They are exclusively Old World in range, being only absent from the Island of Madagascar. In the New World there are no species of the restricted genus *Mus*. The eyes and the ears are large; the pollex is rudimentary, and bears a nail instead of a claw. The tail is largely scaly. All the members of the genus are small animals, some quite minute. In this country there are five species[1] of the genus, viz. the Harvest Mouse, *M. minutus*, which has a body only 2½ inches long with an equally long tail. It is the smallest of British quadrupeds with the exception of the Lesser Shrew. The Wood Mouse, *M. sylvaticus*, is about twice the size; it differs also from the last species in that it

[1] To which a sixth, the "Yellow-necked Mouse," *Mus flavicollis*, may perhaps be added

frequents barns, and is thus sometimes mistaken for the Common Mouse, from which, however, it is to be distinguished by its coloration and longer ears. The latter, *M. musculus,* is too familiar to need much description. A curious variety of it has occurred. This has a thickened and a folded skin like that of a Rhinoceros, and the hair has disappeared. The Black Rat, *M. rattus,* is like a large Mouse, and is smaller and blacker in colour than the "Hanoverian Rat." It is sometimes called the "Old English Rat," but seems nevertheless to be not a truly indigenous Rodent. It has been so defeated by competition with the Hanoverian Rat that it is now not a common species in this country.

The Hanoverian or Brown Rat, *M. decumanus,* is a larger and a browner animal than the last. It is very widely distributed through the globe, no doubt largely on account of the fact that it is readily transported by man. The same is the case with the Common Mouse, whose real origin must be a matter of doubt. The original home of the Brown Rat is thought by Dr. Blanford to be Mongolia. There is so far a justification for the name "Hanoverian Rat" that the animal seems to have reached this country about the year 1728. But there is no reason for calling it, as is sometimes done, the Norway Rat.

Some members of this genus, whose fur is interspersed with spines, or which are quite spiny, have been separated as a genus, *Leggada,* which, however, is not generally allowed.

Closely allied again is *Chiruromys,* which has a strongly prehensile tail, a feature which is not common among the Myomorpha, though *Dendromys,* a tree-frequenting form, and *Mus minutus,* already spoken of, show the same character. Many Mice seem to have prehensile tails, which they can curl round branches; but it is not so fully developed as in the species just named

A number of other genera are referable to the true Mice, the sub-family Murinae of Thomas's classification. The Syrian and African *Acomys* has very spiny fur, so much so that "when it has its spines erected it is almost indistinguishable at the first glance from a diminutive hedgehog." The genera *Cricetomys, Malacomys, Lophuromys, Saccostomus, Dasymys* are restricted to the Ethiopian region. *Nesokia* is Oriental, reaching

also the Palaearctic region. *Vandeleuria, Chiropodomys, Batomys, Carpomys* are Oriental, the last two being confined to the Philippines.

Another peculiar Philippine genus is *Phlaeomys,* of large size, and allied to it is *Crateromys,* originally confounded with it. *Batomys granti* is also confined to Luzon. Its molars are three, like those of the also restricted and Philippine *Carpomys melanurus,* which is an arboreal form. There is a second species, *C. phaeurus.*

Phlaeomys is placed, however, by Mr. Thomas in a distinct sub-family of its own, **Phlaeomyinae**, and is removed from the Murinae.

Hapalomys, with but one species, is Burmese. *Pithecochirus* is

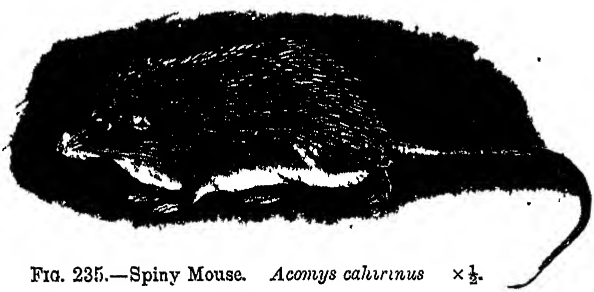


FIG. 235.—Spiny Mouse. *Acomys cahirinus* × ½.

Javanese and Sumatran. *Conilurus* (also known as *Hapalotis*) is a genus containing species which are termed Jerboa Rats, on account of their mode of progression. They are desert and Australian forms. There are sixteen species.

Mastacomys, with one species, is limited to Tasmania. *Uromys,* with some eight species, is from Queensland, and inhabits also the Aru Islands and the Solomon Islands. The Celebesian *Echiothrix,* or *Craurothrix* as it should apparently properly be called, is another genus containing but a single species. *Golunda* is both Oriental and Ethiopian, one species occurring in each region. The beautiful little striped Barbary Mice, *Arviacanthis* (or *Isomys*), are African, north as well as tropical.

The genus *Saccostomus* resembles the Hamsters in the presence of cheek pouches. Its teeth, however, are Murine. It agrees with *Steatomys* in the comparatively short tail. The caecum is rather long.

Sub-Fam. 2. Hydromyinae.—The genus *Hydromys*,[1] of which there are several species, the best known being *H. chrysogaster*, is an exclusively Australian form, and is aquatic in habit. It is a foot or so in length, and has a fairly long tail. The fore- and hind-limbs are webbed, in correspondence with its habits. The Australian Water-Rat is black, with an admixture of golden-coloured hairs dorsally and golden colour below, with a lighter median stripe. The thumb is small, and the webbing of the hands is not so marked as is that of the feet. The molars are only two in each half of each jaw. The caecum is rather small, the measurements of the alimentary canal being: small intestine, 895 mm.; large intestine, 278 mm.; caecum, 70 mm. Allied to the last is *Xeromys*, a genus which is also Australian, but limited to Queensland. It has been established by Mr. Thomas,[2] who discovered that it has the same reduced formula as *Hydromys*. *Xeromys*, however, is not an aquatic animal, and has unwebbed feet.

In the Luzon highlands Mr. Whitehead has discovered, and Mr. Thomas quite recently described,[3] a number of peculiar Rodents. Of these the genera *Chrotomys*, *Celaenomys*, and *Crunomys* are allied to the Australian and New Guinea *Hydromys*.

Chrotomys whiteheadi is unusual among Muridae, in its coloration being marked by a pale stripe down the back. The creature is the size of the Black Rat (*Mus rattus*). It is terrestrial not aquatic in habit, in spite of its likeness to *Hydromys*. The molars, however, are $\frac{3}{3}$.

Crunomys fallax is more like *Hydromys*. It has, however, three molars, as in the last genus But the skull has the flattened form characteristic of *Hydromys* as opposed to *Mus*.

Like *Batomys*, *Celaenomys silaceus* is also somewhat intermediate between *Hydromys* and *Mus* It is described as very Shrew-like in appearance, and has a very pointed muzzle. Its habits Mr. Whitehead is "quite unable even to guess at." Like *Hydromys* and *Xeromys* this Rodent has but two molars.

Sub-Fam. 3. Rhynchomyinae.—The genus *Rhynchomys*, containing but one species, *Rh. soricioides* (of Thomas), is also, as both its generic and specific names imply, a somewhat Shrew-like form in external aspect. The skull, too, is Insectivore-like in its elonga-

[1] For anatomy see Windle, *Proc. Zool. Soc.* 1887, p. 53

[2] *Proc. Zool. Soc.* 1889, p 247.

[3] *Trans Zool. Soc.* xiv. 1898, p. 377.

tion, and the lower incisors are worn to needle-like points. The two molars are excessively minute, and thus the always large gap in the jaws is greatly exaggerated. It is suggested that this Rat is an insect-eater, but nothing positive is known.

Sub-Fam. 4. Gerbillinae.—The Gerbilles form another subfamily, Gerbillinae, of the Muridae, or a family, according to some. The best-known genus is *Gerbillus*, including the Gerbilles proper. These animals are Old World in range, belonging to the three regions of that part of the world. There are a large number of species in the genus, over thirty. They have a Jerboa-like form, with rather long hind-limbs and a long and hairy tail. But the hind- as well as the fore-feet are five-toed. The molar teeth have no trace of tubercles, but only transverse lamellae of enamel.

FIG. 236.—Gerbille. *Gerbillus aegyptius.* × ½.

The incisors are orange; they are white in *Dipus*. *Gerbillus pyramidum* is 90 mm. long, with a tail of 125 mm. The ears are long, 13 mm. The tail has longer hairs at the tip.

Psammomys is in some respects different. The tail is shorter than in *Gerbillus*; its length in an individual of 165 mm. was 130 mm. As in *Gerbillus* there are four pairs of teats, two pectoral and two inguinal. This genus is exclusively Palaearctic in range. *Meriones* has a range co-extensive with that of *Gerbillus*.

Pachyuromys is an Ethiopian genus with a short tail. As the generic name denotes, the tail is not only short but thick and fleshy.

Sub-Fam. 5. Otomyinae.—The allied genera, *Otomys* and *Oreinomys*, are Ethiopian. *Otomys unisulcatus* has a tail shorter than the body, the measurements of a female of this species being 137 mm. with a tail of 87 mm. The ear is long, whence the name; it measured in this specimen 20 mm.

Sub-Fam. 6. Dendromyinae.—The genus *Deomys* is an African form, consisting of only one species from the Congo region. *D. ferrugineus* has a reddish colour as its name implies; the soles are quite naked and the tail is long and slender. It is considerably longer than the body, measuring (minus a fragment of the tip) 172 mm., while the body is 125 mm. long. The characters of the molar teeth, which are three, are intermediate in their form between those of the true Rats and those of the Hamsters.

Dendromys is also Ethiopian in range. There are several species. *D. mesomelas* is a smallish creature, 60 mm. long, with a tail of 90 mm.

Steatomys is another African genus, allied to the last Its tail, however, is only half the length of the body. The two remaining genera are *Malacothrix* and *Limacomys*. Their range is African.

Sub-Fam. 7. Lophiomyinae.—Allied to the Hamsters is the singular East African genus *Lophiomys*, with only one species, *L. imhausi*, of Milne-Edwards.[1] The size is between that of a Rabbit and of a Guinea-pig. The stomach is curved and somewhat intestiniform. It has been termed the Crested Rat on account of the "prominent crest of stiff hair running down the back." The fingers and toes are five, and the very long tail is clad with hair longer than that upon the body generally. The pollex is rudimentary, and the hallux is opposable.

The most remarkable structural feature in this genus concerns the skull, and on account of this it has been regarded as the type of a separate family. The temporal fossa behind the eye is covered over by a complete bony plate, formed by a downgrowth of the parietal, meeting an upgrowth from the malar; this singular arrangement of the bones recalls the conditions which obtain in turtles. The whole skull, moreover, is covered with symmetrically disposed granulations, such as are found in no other mammal; it suggests rather the skull of certain fish. It is believed that the bony plate already referred to is not really a portion of the bones of which it appears to be a prolongation, but merely an ossification of fasciae in this region. The atlas is granulated like the skull; there are sixteen pairs of ribs and a feeble clavicle. The molars are three, and of a peculiar form.

[1] *Nouv Arch. Mus.* iii. 1867, p. 81.

They have, in the case of the first three, transverse ridges, from which stand up two sharp and long tubercles. The other teeth have two ridges. The incisors are pale yellow. The shape of the teeth and the smallness of the caecum suggest that this Rodent is not so purely a vegetarian as others, and that it nourishes itself largely upon insects.

Sub-Fam. 8. Microtinae.—The Voles or Water-Rats form a distinct group of Murine animals, to which the sub-family name of Microtinae has been applied from the genus *Microtus* (more generally known as *Arvicola*), a genus which includes the Water-Rat and Field-Voles of this country. This genus has short ears, and a short and hairy tail. Its build is stouter and clumsier than that of the Rats. The genus is confined to the Palaearctic and the Nearctic regions. In this country there are three species. The best known is the Water-Vole or Water-Rat, *M. amphibius*, which has been seen by most people, and which frequents streams, ponds, and canals. The feet, curiously enough, are not webbed, which seems to argue the recent adoption of an aquatic life. Mr. Trevor-Battye has remarked that this animal, when swimming at leisure, uses its hind-limbs only, carrying the fore pair at the sides like a Seal. The Bank-Vole, *M. glareolus*, is rather a local species in this country. It is a terrestrial Vole, and burrows. The Field-Vole, *M. agrestis*, has become notorious on account of the "plagues," to which its immense numbers have on occasions given rise. It is the smallest species, and has a greyish-brown fur like the Water-Vole, the Bank-Vole being redder. To give an idea of the cost of the depredations of this animal, Mr. Scherren quotes [1] a farmer who gave evidence before the Agricultural Commission to the effect that, putting the damage of one Vole at two pence, the amount of loss suffered on a farm of 6500 acres in two years would be £50,000!

The genus *Fiber* comes very near the last. It is a North American genus. The hind-feet are slightly webbed; the tail is a trifle shorter than the body, and is compressed and scaly, with scattered hairs. The thumb is short, but with a fully-developed claw. As in the last genus, the small and large intestines are roughly of the same length, and the caecum is about one-fourth of the length of either. It is known as the "Musquash."

[1] *Popular Natural History of Animals*, London, 1898.

Of *Fiber zibethicus*, or rather a closely-allied form, *F. osoyoosensis*, from Lake Osoyoos near the Rockies, Mr. Lord writes[1] that it constructs for itself a house of bulrushes built up from the bottom in 3 or 4 feet of water. It is dome-shaped, and rises about a foot out of the water. "If a dead or badly-wounded duck be left on the pool, it is at once seized on, towed into the house, and doomed." Thus it appears that this Rodent, like so many others, is largely carnivorous. It has also been asserted that it eats fish.

Neofiber is an allied genus, North American in range. The species, *N. alleni*, is compared, as regards outward form, with the Water-Vole, *M. amphibius*. It has, however, a shorter tail.

Another very well-known member of this sub-family is the Lemming. The name, however, applies to two quite distinct genera. The genus *Cuniculus*, including the Banded Lemming, *C. torquatus*, is an inhabitant of North America, Siberia, and Greenland. The tail is short, its length being 12 mm. as against a body length of 101 mm. The feet are furred beneath, a not unusual state of affairs in Arctic mammals. The ears are very slight. The thumb is well developed, and bears a claw.

In *Myodes*, on the other hand, which is not so markedly an Arctic animal, though occurring in both Palaearctic and Nearctic regions, the ears are rather bigger, though still smaller than those of *Microtus*. The under surfaces of the feet are similarly furred. The tail is also short. It is commonly said that the two genera are to be distinguished by the furred feet of *Cuniculus*, and by the absence of fur in the present genus. That, according to Tullberg, does not appear to be the case. The differences are thus so much reduced that it seems almost unnecessary to retain the two genera. The best known species of *Myodes* is of course the Scandinavian Lemming, *M. lemmus*. This animal used to occur in this country in Pleistocene times (as did also *C. torquatus*), and recently Dr. Gadow has found remains with skins attached in caves in Portugal. It may still survive in the mountains of the Peninsula.

The actual habitat of the Lemming in Scandinavia is the great tablelands, 3000 feet high in the centre. The migrations do not take place with regularity; even twenty years may elapse before the appearance in cultivated lands of those countless

[1] *Proc. Zool. Soc.* 1863, p. 95.

hordes so familiar (as far as their description is concerned) to everybody. The Lemmings do not return from their exodus. They die from various causes, including combats with one another. Their chief foes, however, are Wolves and Gluttons, Buzzards and Ravens, Owls and Skuas, which batten on the migrant hordes. Their sudden increase in numbers recalls the similar increase at times of the Field-Vole, to which reference has already been made.

Ellobius is an Old-World genus, which leads a "Talpine" life, and has in consequence rudimentary external ears and very small eyes. The tail is short. Contrary to what might be expected from its mode of life, the claws upon the digits are not strong.

The remaining genera of Vole-like Murines are *Phenacomys* and *Synaptomys* from North America, and *Siphneus* from Palaearctic Asia. *Evotomys* is one of those genera which are common to both the Palaearctic and the Nearctic regions, but the bulk of the species are North American.

Sub-Fam. 9. Sigmodontinae.—This is the name given to another sub-family of Murine Rodents, a group which includes the Hamsters in the Old World as well as a large number of South American genera of Rat-like animals. Of these latter there are a very large number, the bulk of the group being American.

The Hamsters, genus *Cricetus*, as it is usually called, although apparently the correct name is *Hamster*, are Old-World forms of Pouched Rats. The Common Hamster, *C. frumentarius*, is about 210 mm. long, with a tail of 58 mm. It has cheek pouches. The small and the large intestines are not very unequal in length, and the caecum is fairly large, being about one-sixth to one-seventh of the length of either. It is a purely vegetable-feeding creature, and in Germany where it occurs (and from which language its vernacular name is derived), hibernates during the winter in its burrow, having previously surrounded itself with a great accumulation of food carried thither.

To North America are peculiar the genera *Onychomys*, *Sigmodon*, and *Peromyscus*. The genus *Sigmodon*, the Cotton Rats, reaches Central America, and even gets a little farther south. The other two genera, though mainly North American, also extend their range to the south. *Onychomys* has hairy foot-

pads, a state of affairs which characterises a number of these Rodents.

The genera *Megalomys, Chilomys, Reithrodontomys, Eligmodontia, Nectomys, Rhipidomys, Tylomys, Holochilus, Reithrodon, Phyllotis, Scapteromys, Acodon, Oxymycterus, Ichthyomys, Blarinomys, Notiomys* are South American forms. *Oryzomys* and *Rheithrodontomys* are common to both parts of the New World.

The genus *Ichthyomys* is remarkable on account of its un-Rodent-like habits and of certain associated structural changes. *I. stolzmanni* was obtained from Mount Chanchamays in Peru at an altitude of 3000 feet, it is a habitual fish-eater, and lives in streams. Another species, *I. hydrobates*, was formerly referred to *Habrothrix*. The skull shows likenesses to that of the Australian *Hydromys*; but the most marked characters of adaptation are those of the teeth and caecum. The cutting edges of the upper incisors form a reversed V of obvious use in holding a slippery fish. The caecum is much reduced, short, and narrow. The general Otter-like shape of the creature is largely due to its flattened head, though its "size and general proportions are much as in the common Black Rat." [1]

This sub-family contains a number of genera from Madagascar, viz. *Brachytarsomys, Nesomys, Hallomys, Brachyuromys, Hypogeomys, Gymnuromys*, and *Eliurus*.

Sub-Fam. 10. Neotominae.—The last sub-family of the Muridae is that of the Neotominae, containing the North American genera *Neotoma, Xenomys, Hodomys*, and *Nelsonia*.

Fam. 3. Bathyergidae.—This family contains several genera which consist of subterranean forms. All these Rodents agree in a number of characters, of which the principal are as follows:—

The eyes are very small, and the external ears are reduced to the merest fringe of skin round the aural aperture. The legs are short, as is the tail; the hair-covering is reduced—a reduction which finds its culmination in the nearly nude *Heterocephalus*. Being burrowing creatures, a number of other modifications in accordance with this mode of life are to be seen in their structure. The upper incisors stand out in front of the closed lips, and prevent the entrance of earth. For the same reason

[1] See O. Thomas, "On some Mammals from Central Peru," *Proc. Zool. Soc.* 1893, p. 333.

the nostrils are small, and the forehead but little expanded between them.

The genus *Bathyergus* contains but a single species, the Cape Mole-Rat, which is found in Southern Africa; it is of moderate size, not exceeding a small Rabbit in dimensions. On the fore-limbs are exceedingly long claws, of which that borne by the second finger is the longest, and the claw of the thumb the shortest. The hind-feet have by no means such long claws. The scratching and burrowing is naturally chiefly effected by the fore-limbs. The small and large intestines are of equal length, and each is rather more than six times the length of the caecum; in these measurements the present genus differs from the next.

Georhychus.—Of this African genus there are about ten species. The claws are not so long as in the last genus, but there are, as in *Bathyergus*, four molar teeth on each half of each jaw. The intestinal measurements in an example of *G. capensis* were: small intestine, 25 inches; caecum, 4 inches; large intestine, 15 inches.

The genus *Myoscalops* or *Heliphobius* (also with an African range) has six back teeth on each side. A number of species sometimes referred to the last genus are placed here by Mr. Thomas. The claws are small.

One of the most remarkable genera of this family is the little *Heterocephalus* from Abyssinia and Somaliland. As Mr. Thomas justly remarks,[1] it "is a peculiar-looking little creature, about the size of the Common Mouse, but looking almost more like a tiny hairless puppy on account of its nearly naked skin, small eyes, and peculiar physiognomy." Though apparently naked, there are numerous scattered hairs over the entire body, and the toes are fringed with stiffish hairs, which must be advantageous to a burrowing animal. There are two species, *H. glaber* (originally described by Rüppell), and *H. phillipsii*, of which our knowledge is due to Mr. Thomas. The length of the entire creature including the tail is not more than 134 mm., both species being approximately of the same dimensions. Mr. Lort Phillips, the discoverer of the species which bears his name, writes "that this little creature, called 'Farumfer' by the Somali, throws up in places groups of miniature craters, which exactly resemble volcanoes in active eruption. When the little beasts were at

[1] "Notes on the Rodent genus *Heterocephalus*," *Proc. Zool. Soc.* 1885, p. 845.

work, I used frequently to watch them, and found that the loose earth from their excavations was brought to the bottom of the crater, and sent with great force into the air in a succession of rapid jerks, and that they themselves never ventured forth from the shelter of the burrows." [1]

Fam. 4. Spalacidae.—"The Spalacidae," observes Dr. Blanford, "are sometimes called rodent moles, and resemble a mole in general aspect, having cylindrical bodies, short limbs, small eyes and ears, large claws, and a short or rudimentary tail." The existence of a spiral valve in the caecum may perhaps characterise this family; but it has at present only been found in the two genera *Spalax* and *Rhizomys*.

Spalax has inconspicuous eyes and external ears. The tail is totally absent. The lower incisors are more developed than in other Rodents; they project in a bony sheath beyond the posterior end of the ramus of the lower jaw. The scapula is long and narrow. The large intestine is half the length of the small intestine. The animal seems to have only two pairs of teats, one pectoral the other inguinal.

Spalax typhlus of Egypt, which is probably not different from the European form, makes extensive burrows, some of the branches being even 30 to 40 yards in length. In a "domical chamber," situated along the course of one of these burrows, Dr. Anderson found no less than 68 bulbs stored up. Its eyes are mere black specks among the muscles, but they appear, however, to have a proper organisation. There are altogether eight species of the genus, which is entirely Palaearctic in its range.

The genus *Rhizomys*, including a number of species known as Bamboo Rats, is purely Oriental in range. *Rh. sumatrensis* reaches a length of 19 inches; the better-known species, *Rh. badius*, is at most only 9 inches in length—in both cases the measurements are exclusive of the tail, which is a quarter to one-third of the length of the body, and is not scaly but nearly naked, with a few scattered hairs. The molars are three, and the incisors usually orange in colour; but sometimes the upper incisors are white as in *Rh. badius*. There are thirteen dorsal vertebrae. In *Rh. pruinosus* the large intestine is considerably longer than the small intestine; the lengths of the two sections of the gut are 42 and 30 inches respectively. In another

[1] *Proc. Zool. Soc.* 1885, p. 611.

species the large intestine is slightly shorter than the small intestine. In *Rh. badius* the two parts of the gut are almost exactly equal in length. There are three pairs of inguinal and two pairs of pectoral teats. The name *Rhizomys* appears to have been given to the animals of this genus for the reason that they feed largely on roots. They burrow, and, like many other burrowing animals, feed in the evening. As is the case with other forms, *Rhizomys* is said to burrow with the assistance of its teeth as well as of its claws.

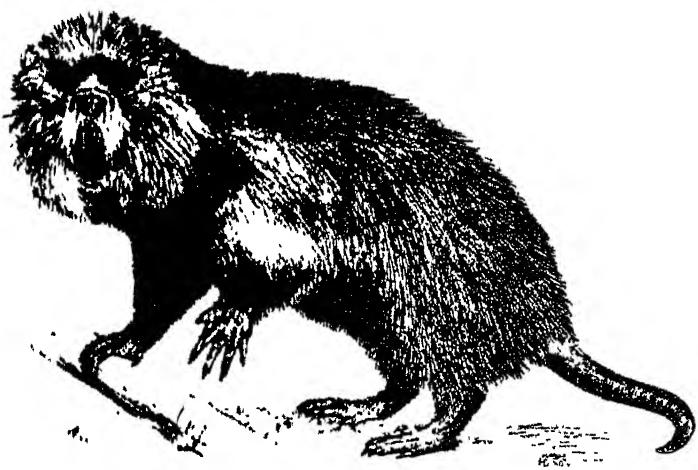


FIG. 237.—Bamboo Rat. *Rhizomys badius.* × ½.

Tachyoryctes is an African genus closely allied to the last. There are three Ethiopian species. It is mainly to be distinguished by the different pattern upon the grinding surface of the molars.

Fam. 5. Geomyidae.—This family of burrowing Rodents is limited to North and Central America. The animals have cheek pouches, and small eyes and ears, in accordance with their mode of life. The claws of the fore-limbs are very strongly developed.

The genus *Geomys* contains some eight species, which are Central and North American, not extending, however, far north. The incisors of the upper jaw are grooved with two grooves. There are three pairs of teats—one axillary, and the two remaining inguinal.

Thomomys, without grooves on the incisors, reaches to Canada in the north, and does not extend as far south as the last genus.

Allied to this family, and indeed united with it by Tullberg, but kept separate by Thomas, is the

Fam. 6. Heteromyidae.—The members of this family are also American, but are not confined to the northern-central regions of that continent, for the genus *Heteromys* extends into South America.

The genus *Dipodomys*, with twelve species, is of a Jerboa-like form, as the following measurements of an example of *D. merriami* will show. The length of the head and body was 85 mm.; of the tail 127 mm.; the hind-foot is 32 mm. It has but four toes. The hind-limb is longer than the front-limbs.

In *Perodipus* the same form is exhibited. There are, however, five toes, and the sole of the foot is hairy. The axis vertebra and the two following vertebrae are fused together.

Perognathus is a third genus. It has the same general slender form, but the tail is not so long, being but little longer than the body. The hind-limbs, too, are shorter. The teats of this and of *Perodipus* are as in *Geomys*. The two remaining genera of the family are *Heteromys* and *Microdipodops*.

Fam. 7. Dipodidae.—This family consists of small, plain-living, and leaping or arboreal creatures, commonly known as

FIG. 238.—Jerboa. *Dipus hirtipes*. × ⅓. Eastern Europe.

Jerboas. The main anatomical characters of the family are the following:—There is a large infra-orbital foramen. The molars are always reduced, the premolar being either absent in the lower jaw alone or in both jaws. This family presents an obvious likeness to *Dipodomys* (hence the name of the latter) and to some other members of the American family Heteromyidae

There is even the same ankylosis of the neck vertebrae. We find, moreover, the same association of long-legged and shorter-legged forms that characterises the Heteromyidae.

The typical genus *Dipus* is a smallish quadruped with long naked ears and a long tail. The ten species are all Palaearctic in range. The fore-limbs are short and five fingered, and the short pollex has no claw; the hind-limbs are excessively long and only three-toed. The bony structure of these limbs is remarkable. The three metatarsals are elongated almost like those of a bird, and are ankylosed together. The digits have long phalanges which alone reach the ground as the animal hops. It is a curious fact, and one not so easily identifiable with the way of life, that the neck vertebrae of this genus are ankylosed together with the exception of the atlas, which is free; the arrangement is precisely like that of the Sperm Whale. The last vertebra is, however, sometimes free. The Jerboas not only leap but they burrow, and their strong incisors are said to be used in burrowing through stony ground. They are eaten by the Arabs, and are, or have been, called Daman Israel, *i.e.* Lamb of Israel. In *D. hirtipes* the body and tail measure respectively $4\frac{1}{2}$ and 7 inches. The hind-feet have a tuft of long hairs below. Mr. W. L. Sclater's newly-founded genus *Euchoreutes*[1] is somewhat more primitive in its characters than is *Dipus*. The general form is the same, with long ears and a long tail. But there are five toes to the hind-limb, the two lateral ones though nailed being much shorter than the middle three. It has a "long pig-like snout," and the tail is cylindrical as in most other Jerboas, with a tuft of longer hairs at the end. The incisor teeth, grooved in *Dipus*, are here smooth, as in *Alactaga*. The species was probably obtained "in the sandy plains round the city of Yarkand."

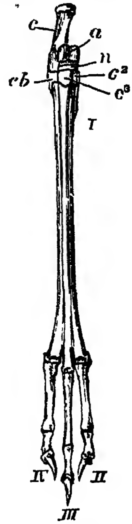


FIG. 239.—Bones of right pes of Jerboa, *Dipus aegyptius*. ×$\frac{3}{4}$. *a*, Astragalus; *c*, calcaneum; c^2, middle cuneiform; c^3, outer cuneiform; *cb*, cuboid; *n*, navicular; I-IV, first to fourth toes (From Flower's *Osteology*.)

[1] *Proc. Zool. Soc.* 1890, p. 610.

Alactaga is much like *Euchoreutes*, it has five toes, a cylindrical tufted tail, the hairs at the end distichous, smooth incisors, and a premolar present in the upper jaw. It also differs from *Euchoreutes* by the much smaller auditory bulla as well as in the fact that the infra-orbital foramen has no separate passage for the nerve, which passage is to be distinguished in both *Dipus* and *Euchoreutes*. The best-known species is the Siberian Jumping Rabbit, *A. jaculus*. Beneath the ends of the three main toes of the feet are remarkable fan-shaped pads. In *A. decumana* the body and tail measure 7 and 10 inches respectively, the ears 2 inches. *Platycercomys*, a fourth genus of the family, is much less known and is to be differentiated from the last three genera by the fact that it has no premolars at all, the grinding tooth formula being thus $\frac{3}{3}$. The tail too is flattened and "lancet shaped." It extends from Siberia to Nubia, and thus just enters the Ethiopian region.

The above are the more typical Jerboas. There remain several forms which are not at all Jerboa-like in their way of life, but are nevertheless, on anatomical grounds, placed with them. *Zapus*, an American genus, with the exception of one Palaearctic species, is transitional in that its hind-legs are rather long, but there is not so much difference between them as in the typical Dipodidae. *Sminthus* is at the opposite extreme to *Dipus*. Its feet are short and of equal length, it climbs in trees, and may perhaps be looked upon as nearest of all Dipodidae to the ancestral form of the group.

Fam. 8. Pedetidae.—The genus *Pedetes* contains but one species, *P. caffer*, the Cape Jumping Hare. The animal suggests a large Jerboa in appearance on account of its jumping habits, the long hind-limbs, and the long tail. The length of a fair-sized example is some 17 inches, with a tail of the same length. The eyes and ears are large. The hands are five-fingered and the feet only four-toed, the hallux being of course the absent digit. In the skeleton it is interesting to note that the second and third cervical vertebrae are so close together that there can be no free movement; interesting because in *Dipus* the cervicals are actually ankylosed. The dorsal vertebrae are twelve. The small intestine is long, measuring 7 feet 4 inches, while the caecum is short, being only 8 inches long. The large intestine is 3 feet 10 inches long. The gall-bladder appears to be

absent,[1] an exceptional state of affairs in Rodents. A singular fact in the anatomy of this animal is the existence of a septum dividing the lower part of the trachea. This is sometimes met with in birds. As might be supposed from its large eyes, the Spring Haas, as the animal is sometimes called, is nocturnal. Its long hind-limbs permit it to leap enormous distances. It is a burrowing Rodent.

SECTION 3. HYSTRICOMORPHA.

Fam. 1. Octodontidae.—The Rodents of this family are of small to moderate size, the only, relatively speaking, giant in the family being the "Water-Rat," *Myocastor*. The toes are with but one exception not reduced; the tail is long in the majority of the genera. The teats are placed high up on the sides of the body. The clavicle is fully ossified. All the genera are South or Central American in range with the exception of *Petromys*.[2]

Sub-Fam. 1. Octodontinae.—*Octodon* has four species, which are all Chilian, Peruvian, and Bolivian in distribution. The Degu, *O. degus*, has a length of 160 mm., with a tail 105 mm. long. The ears are 18 mm. long. At the roots of the claws are longish and stiff hairs which appear to serve as "combs." The tail has long but sparsely scattered hairs. There are twelve pairs of ribs. The lengths of the various sections of the intestine are as follows: small intestine, 680 mm.; caecum, 90 mm.; large intestine, 390 mm These animals live in large companies. Closely allied is the genus *Habrocoma* (more correctly, as it appears, to be written *Abrocoma*), with two species. *H. bennetti* is 204 mm. long, with a tail of 103 mm. The ears are long, 22 mm. The fore-feet have no outward trace of the thumb. Stiff hairs like those that characterise *Octodon* are found also in this genus. The fur is very soft. The furring of the tail is much thicker than in *Octodon*.

Spalacopus with but a single species, *S. poeppigi*, is a burrowing animal, from which indeed, and on account of its resemblance to *Spalax*, it has received its name. The ears in accordance with the underground life are short, only 5 mm. in length in an

[1] Parsons, *Proc. Zool. Soc.* 1898, p. 858.

[2] Very probably this form should be rather, as it is by Thomas, referred to the neighbourhood of *Pectinator*, which would clear up the geographical anomaly.

example of 120 mm. The tail too is reduced, being in the same example only 42 mm. in length. As in the last two genera the large intestine is about one half of the length of the small intestine.

The "Tuco-tuco," genus *Ctenomys*, has also short ears and tail. The claws of the fore-feet are longer than those of the hind-feet.

A related form is *Aconaemys* (better known as *Schizodon*), with similar external characters; it inhabits high localities on the Andes.

Petromys is the only genus of the sub-family which is not American in habitat. It is an African form and there is but one species. Its anatomy conforms to that of the genera already considered. The main difference in structure is shown by the teeth. Their surface is uneven, and differs from that of other Hystricomorphs "in that the enamel to the inside of each upper jaw-tooth and outside on each lower jaw-tooth forms two tubercles, to which correspond grooves in the reverse position of the applied teeth."

Sub-Fam. 2. Loncherinae.—The genus *Echinomys* with thirteen species belongs to the Neotropical region. The members of the genus are entitled "Spiny Rats" since they have spines mixed with the fur. The tail is long and the ears are very well developed. Both feet are five-toed. The tail is scaly as well as haired. *Trichomys* (also called *Nelomys*) is very close to the above, and is also from the same part of the world.

The genus *Cannabateomys* contains but one species, *C. amblyonyx*, which was formerly included in the genus *Dactylomys*, but has lately been separated by Dr. Jentink.[1] The animal is Brazilian and has a total length of 520 mm., of which 320 mm. belong to the tail. It is a climbing rat, and in accordance with that way of life has undergone some modifications. The fore-feet are four-toed, the two middle toes being markedly longer than the outer ones. The hind-feet are five-toed with the same greater development of the two middle toes. The claws are small and somewhat nail-like.

Dactylomys, also Brazilian, and with but one species, *D. dactylinus*, differs from the last in the fact that the molars are simpler in form; they are divided into two lobes, each of which

[1] *Notes Leyd. Mus.* 1891, p. 105.

has but a single enamel fold, whereas in *Cannabateomys* these teeth have several enamel folds. The tail, moreover, is but slightly hairy.

Loncheres with eighteen species is another Neotropical genus allied to the foregoing. Small spines are, as in many of these genera, intermingled with the fur. This genus has as many as seventeen dorsal vertebrae, which is an unusually large number. *L. guianae* is known as the "Porcupine Rat." Allied genera, also South American, and without spines in their fur, are *Mesomys*, *Cercomys*, and *Carterodon*.

The South American *Thrinacodus* is also known by one species,[1] *T. albicauda*, which has rather more than the distal half of the long tail of a white colour. The fore-feet have four toes. The ears are broad and short.

Sub-Fam. 3. Capromyinae.—A third sub-family of the Octodontidae is formed by the genera *Myocastor*, *Capromys*, *Plagiodontia*, and *Thrynomys*, which are all Neotropical forms with the exception of the last, which is African.

Thrynomys (better known perhaps as *Aulacodus*) is a genus of African Rodent, containing some four species. The best-known of these is *T. swinderniamus*, the Ground-Rat of West and South Africa. Its structure has been investigated by Garrod,[2] by Tullberg,[3] and by myself.[4] The fur is mingled with flattish bristles; the tail is moderately long, about half as long as the body. The fore-feet are five-toed, but the two toes at each end of the series are quite small. The hind-feet are only four-toed, the hallux being absent. The claws of the hind-feet are stronger than those of the fore-feet. The ears are not long. The limbs are decidedly short, hence the name of "Ground-Pig" sometimes applied to this animal. The molars are four in number in both jaws. The incisors of the upper jaw are twice grooved. There are thirteen dorsal vertebrae. The length of the small intestine is $60\frac{1}{2}$ inches, that of the large 49; the caecum is short, being only 8 inches long. It is a remarkable fact that the acromion is joined to the rest of the spine of the scapula by a joint.

Myocastor, a name which seems to have the rights of priority over the more familiar *Myopotamus*, applies to a large South American aquatic Rodent. The general aspect of the animal

[1] Günther, *Proc. Zool. Soc.* 1879, p 144.
[2] *Proc. Zool. Soc.* 1873, p. 786.
[3] *Loc. cit.* (on p. 458), p. 123.
[4] *Proc Zool. Soc.* 1892, p. 520.

suggests a Water-Rat of large size (it has been exhibited in shows as a phenomenal product of London sewers !); the tail is nearly as long as the body. The ears are small. The limbs are short. The tail is naked. The hind-feet are webbed, but not so much so as in *Hydromys*. A small thumb is present. The animal has thirteen pairs of ribs; the molars are four in each jaw. The large intestine is more than three times the length of the small, and the caecum is, as in the last genus, relatively short.

Capromys is a genus[1] which is remarkable on account of its restricted distribution. It is found only in the islands of Cuba and Jamaica. There are four species, of which *C. melanurus* is a dark brown-coloured animal with a blacker tail, nearly as large as a Rabbit. The native name of this Rodent is "*hutia.*" It is also remarkable for having a stomach more complicated than is the rule among the mammals of this group. The organ is divided by two constrictions into three compartments. In *C. pilorides* the liver is occasionally divided up in an extraordinary fashion into small lobules. *Capromys* has the large number of sixteen dorsal vertebrae.

Fam. 2. Ctenodactylidae.—For these African genera it seems admissible to form a distinct family, though Thomas, and Flower and Lydekker, only allow to the genera *Ctenodactylus, Pectinator*, and *Massoutiera* sub-family rank. On the other hand, Tullberg removed these genera entirely from the Hystricomorph section and placed them as a section of the sub-tribe Myomorphi of the tribe Sciurognathi. It was chiefly the form of the mandible which led to this placing, for in these Rodents, as in all Squirrel- and Rat-like Rodents, and unlike what is found in the Hystriciform genera, the angular process of the mandible is not bent sideways.

The genus *Ctenodactylus* derives its name from the peculiar strong bristles which form a comb-like structure upon the hind-feet and hide the claws; these are stated to be for the purpose of dressing the fur. The Gundi of North Africa, *C. gundi*, has a length of 190 mm., with a short tail of 17 mm. The ears are only moderate in size. The dental formula of the molars is $\frac{4}{3}$. The incisors are white. The feet have four digits, and the hind-limbs are the longer. The large intestine is distinctly longer than the small intestine.

[1] See Dobson, *Proc. Zool. Soc.* 1884, p. 233.

Pectinator spekii is the only representative of a genus not far removed from *Ctenodactylus*; it is a smallish Rodent, 6 inches in length, exclusive of a rather bushy tail nearly 3 inches long. It comes from Abyssinia. It has somewhat the appearance of a Squirrel, which is heightened by the fact that when sitting the tail is arched over the back; when running the tail is carried out straight. There are only four toes visible externally on both fore- and hind-limbs, but pollex and hallux exist in the skeleton, with a single phalanx each. There is only a single pair of mammae, and in correspondence with this but two or three young are produced at a time. The hind-feet have bristles very much like those of *Ctenodactylus*. The molars, however, are $\frac{4}{4}$. There are twelve ribs, of which six reach the sternum. The latter is made up of six pieces, and the manubrium in its breadth anteriorly suggests that of the Vizcachas. The clavicles are present.[1]

Fam. 3. Caviidae.—This family, which includes the Cavies and

FIG. 240.—Carpincho. *Hydrochoerus capybara.* × $\frac{1}{12}$.

the Capybara, is entirely South American and West Indian in distribution. It embraces animals of fair to large size, the Capybara

[1] Peters, *Trans. Zool. Soc.* vii. 1871, p. 397

(or Carpincho) being the greatest of existing Rodents. The ears are well developed. The toes are commonly reduced, and the members of this family possess only a rudimentary tail. The hair though rough is not spiny. Other characters had best be deferred until the several genera are treated of. We shall begin with the giant of the family, the genus *Hydrochoerus*. This genus contains but a single species, *H. capybara* of South America. It reaches a length of some 4 or 5 feet. The ears are not large; the tail is completely absent. The fore-feet are four-toed, the hind-feet three-toed; the digits are webbed, though not to a very great degree, and the nails have the appearance of hoofs. There are fourteen dorsal vertebrae; the clavicle is absent. In the skull the paroccipital processes are of great length. The infra-orbital foramen is large. The most remarkable fact about the teeth is the great size of the posterior molar of the upper jaw; it has fourteen folds of enamel, more than all the anterior teeth possess collectively. The incisors are white and grooved in front. The measurements of the alimentary tract as given by Tullberg are: small intestine, 4350 mm.; caecum, 450 mm.; large intestine, 1500 mm.

The Capybara or Carpincho is largely aquatic in its habits.

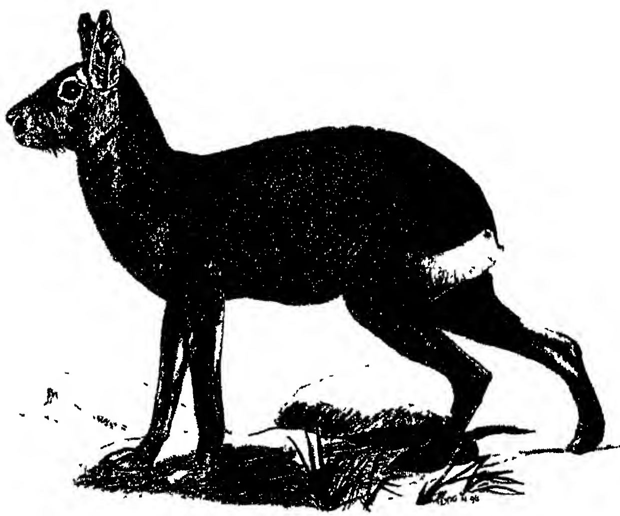


FIG. 241.—Patagonian Cavy. *Dolichotis patachonica*. $\times \frac{1}{10}$.

Their "favourite locality," writes Mr. Aplin,[1] "is a broad laguna

[1] "Field Notes on the Mammals of Uruguay," *Proc. Zool. Soc.* 1894, p. 297.

in the river, furnished with open water, and also beds of 'camelotes,'—a sloping open grassy bank on one side, where the Carpinchos can lie in the daytime in the cooler weather, sleeping and basking in the sunshine; on the other a low shelving bank, clothed with 'Sarandi' scrub growing out into the black reeking mud and shallow water beyond." They always take to the water when alarmed, at a rate and with a gait which reminded Mr. Aplin of a Pig. When in the water they swim slowly with the upper part of the head, including nose, eyes, and ears, above the surface. But they can dive for a considerable time and distance, and baffle their enemies by seeking the shelter of a mass of water-plants, and lying there with their noses only just above the surface.

The genus *Dolichotis*[1] has long ears, and generally resembles a rather long-legged Hare in appearance. The front-feet are four-toed, the hind three-toed. The Patagonian Cavy, as this animal is called, has twelve dorsal vertebrae, and rudimentary clavicles.[2] The paroccipital processes are long, the incisors are white, and are not grooved in front. The sternum has six pieces, and seven ribs reach it.

Cavia, including the species *C. porcellus*, the Guinea-pig (which name is a corruption apparently of Guiana pig), has the same number of toes on its hind- and fore-feet as has the Capybara. The name applied to the wild stock whence our Guinea-pig is derived is the Restless Cavy. The fur is greyish; of the domestic animals the colour is too well known to need description.

Fam. 4. Dasyproctidae.—The genus *Coelogenys* includes but two species. *C. paca*, known as the "Spotted Cavy" or "Paca," has a brown body, with white spots like those of a Dasyure; it is one of the largest of Rodents, and has a quite short tail The hand and foot are both provided with five digits; but the thumb is small, and in the foot the three middle toes considerably exceed the others in length. The hind-foot is practically three-toed. The tibula is not nearly so reduced as in *Dolichotis*. The skull of the animal is remarkable for the extraordinary development in breadth of the jugal arch, which is sculptured externally. There is a large cavity formed below, at the maxillary end of this huge

[1] Beddard, *Proc. Zool. Soc.* 1891, p. 236.

[2] These are stated by Tullberg to be absent. I have found them, but they are very small bones, not more than half an inch long.

arch, by the curving inwards of the bone, which lodges a cavity continuous with the mouth. The palate has anteriorly a ridge on either side, and is thus divided from the sides of the face in a way which is not found[1] in the allies of *Coelogenys*. Clavicles are present. There are thirteen dorsal vertebrae. The incisors are coloured red in front. The animal is South American, and in that continent is limited to the Brazilian sub-region. This, the best-known species of Paca, is called the Gualilla by the natives of Ecuador; in the same district another form is met with which the natives term Sachacui (signifying Forest Cavy). It is very often the case that a different native name expresses a real specific difference; and to the latter form M. T. Stolzmann has given the name of *C. taczanowskii*.[2] This form, unlike the common Paca, which is fond of forests and low-lying ground in the neighbourhood of water, is alpine in habitat, living upon mountains of 6000 to 10,000 feet. It burrows in much the same way as its congener, and is greatly sought after as food, its meat possessing an "exquisite taste." It is pursued by dogs, by whose aid one of the two entrances to the burrow is guarded, and the creature is smoked out and killed with a stick.

The genus *Dasyprocta*, containing those Rodents known as Agoutis, is divisible into several species, apparently about twelve, all of which are, like the Pacas, confined to the Neotropical region. They have, however, a much wider range within that region, and occur as far north as in Central America and in some of the West Indian Islands. They are of rather smaller size than the Paca, and are without spots. The colour is of a golden brown in some forms, but usually has a freckled, grizzled, greenish kind of appearance. The tail is stumpy, the hind-limbs are distinctly longer than those of the Paca, and the two lateral toes have disappeared from the feet—a concomitant as it seems of the Agouti's greater powers of running. The three metatarsals are closely pressed together, and the foot is as it were on the way towards the highly-modified foot of the Jerboa. The fore-feet are, however, five-toed. The clavicle is rudimentary,[3] whereas it is well developed in the Paca. The skull has not the peculiar modifications of that of the last-mentioned type. The sternum has seven

[1] There is a faint development of these ridges, but behind the palatine foramina in *Dasyprocta aguti*.

[2] *Proc. Zool. Soc* 1885, p. 161.

[3] Or absent?

pieces, and eight ribs reach it. A curious difference between this genus and the last is in the relative proportions of the regions of the intestine. The figures given by Tullberg for the two animals are—for *Coelogenys*, small intestine, 4800 mm.; caecum, 230 mm.; large intestine, 21,000 mm.;—for *Dasyprocta aguti* the same author gives: small intestine, 4200 mm.; caecum, 200 mm.; large intestine, 1000 mm. The Agouti, says Mr. Rodway,[1] is as wily as

FIG. 242.—Agouti. *Dasyprocta aguti* $\times \frac{1}{10}$.

the Fox. "If chased he will run along the shallows of a creek to hide his scent from the dogs, or swim over and back again several times for the same purpose. He never runs straight when pursued, but doubles, often hiding until a dog has passed, and then making off in a different direction. Like the fox he has been hunted for a very long period, and, like Reynard, has grown wiser with every generation."

Fam. 5. Dinomyidae.—The genus *Dinomys* of Dr. Peters[2] is a very little known and remarkable form from South America allied to the Capybara, the Chinchilla, and other South American Rodents. It is only known by a single example found wandering about a courtyard in a town of Peru. It is externally like, and of about the same size as the Paca, but has a hairy tail. The animal is four-toed and plantigrade; the ears are short, and the nostrils are S-shaped. It is usually regarded as belonging

[1] *In the Guiana Forest*, London, 1894. [2] *MB. Ak. Berlin*, 1873, p. 551.

to a separate family which will include but the one species, *D. branickii.*

Fam. 6. Chinchillidae.—This family, likewise South American, contains three genera,[1] all of which agree in having long limbs, especially the hind-limbs, and a bushy and well-developed tail. The hair is exceedingly soft, hence the commercial value of "chinchilla."

The genus *Chinchilla,* containing but a single species, *C. laniger,* is a small and squirrel-like creature, living at considerable heights in the Andes. The eyes, as it is a nocturnal creature, are naturally large; and so also are the ears. The fore-feet have five toes, the hind-feet only four; they are furnished with feeble nails. The innermost toe of the hind-foot has a flat and nail-like claw. There are thirteen dorsal vertebrae, and the long tail has more than twenty. The clavicle is well developed, as in the other genera of this family. The large intestine of this animal is extraordinarily long; the proportions of the different regions of the gut are shown by the following measurements: small intestine, 820 mm.; caecum, 125 mm.; large intestine, 1340 mm. Such a disproportion between the large intestine and the small, to the advantage of the former, is a very strange fact in the anatomy of this Rodent.

The genus *Lagidium* (also called *Lagotis*), which includes "Cuvier's Chinchilla," is also a mountain dweller. There are several species of this genus, which differs from *Chinchilla* by the complete abortion of the thumb and of the great toe. The intestinal proportions are those of *Chinchilla.* The ears and tail are long. *L. cuvieri* measures $1\frac{1}{2}$ feet in length.

Lagostomus, again, has but one species, *L. trichodactylus.* The animal has a tail about half the length of the body. The digits are reduced as compared with *Chinchilla,* there being but four on the fore- and three on the hind-feet. There are only twelve dorsal vertebrae, and seven ribs reach the sternum. In the skull a distinguishing mark from the last two genera is the separation of the infra-orbital foramen into two by a thin lamella of bone. The large intestine is between one-half and one-third the length of the small intestine, and thus differs much from that of *Chinchilla.*

[1] An account of the three genera is to be found in *Trans. Zool. Soc* i. 1833, p. 35, by Mr. E. T. Bennett.

The Vizcacha lives in societies of twenty to thirty members,[1] in a "village" ("Vizcachera"), a dozen or so of burrows, which intercommunicate. They lie at home during the day and come out in the evening. Their burrows, like those of the Prairie Marmot, harbour other creatures, which apparently live on amicable terms with the Vizcachas; such are the burrowing owl, a small swallow, and a *Geositta*. The Fox also affects these burrows, but then he ejects the rightful owner of the particular burrow

FIG. 213.—Vizcacha. *Lagostomus trichodactylus*. × 1/10.

which he selects. When the young Foxes are born the vixen hunts the Vizcachas for food. The Vizcacha has a most varied voice, producing "guttural, sighing, shrill, and deep tones," and Mr. Hudson doubts if there is "any other four-footed beast so loquacious or with a dialect so extensive." These animals are very friendly, and pay visits from village to village; they will attempt to rescue their friends if attacked by a Weasel or a Peccary, and to disinter those covered up in their burrows by man.

Fam. 7. Cercolabidae.—A number of the characters which differentiate this family from the Hystricidae or Ground Porcupines of the Old World are given under the description of the latter. The principal external characters are the prehensile tail, the admixture of spines with hairs, and the nature of the sole of the foot. In these points the New-World Cercolabidae differ from the Old-World Hystricidae. It is interesting to notice that

[1] Hudson, "On the Habits of the Vizcacha," *Proc. Zool. Soc.* 1872, p. 822.

in both families we have long-tailed and short-tailed forms. *Cercolabes* corresponds to *Atherura* or *Trichys*, and *Erethizon* to *Hystrix*.

The genus *Erethizon*, the "Urson" of Canada, has a short, stumpy tail. Its spines are almost hidden by enveloping hair. The fore-feet have four, the hind-feet five toes. The short tail of this creature is remarkable when we reflect upon its climbing habits. It appears, however, to be a weapon with which it strikes sideways at the enemy.

Of the Neotropical genus *Cercolabes* (sometimes called *Sphingurus, Synetheres,* or *Coendou*) there are some eight or nine species, all found in Central and South America. The animal is

FIG. 244.—Brazilian Tree Porcupine. *Sphingurus prehensilis.* × ⅛.

arboreal, and has in correspondence with that habit a prehensile tail. The spines are not so stout as in the Ground Porcupines, and are often coloured yellowish or reddish. In correlation with its tree-frequenting habits the bones of *Cercolabes* show certain differences from those of the Ground Porcupines. The scapula is broader and rounder in front than is that of *Hystrix;* the phalanges of the thumb (which is rudimentary) are fused together as in the Canadian *Erethizon;* but those of the very small hallux are also fused, whereas in *Erethizon,* as in *Hystrix,* they are separate. In one species, *C. insidiosus,* Sir W. Flower states that there are as many as seventeen dorsal vertebrae and thirty-six caudals. The tail is thus very long. In *C. villosus* there are fifteen dorsals and twenty-seven caudals; eight ribs reach the sternum, which is composed of seven pieces, the

sixth being very small. The clavicles are well developed. A curious fact about *C. villosus* is that the acetabular cavity is perforate (on both sides), or at least only closed by membrane. In many forms of Rodents the bone is very thin in this region. This fact perhaps lessens the significance of the perforation of the acetabulum of *Echidna* (see p. 109).

Of the allied genus *Chaetomys*, also Neotropical, there is but a single species, which inhabits Brazil. It has a nearly completely closed orbit, a feature which differentiates it from the last animal, and one which also shows it to be a more modified form. The spiny covering is less pronounced than in its allies.

Fam. 8. Hystricidae.—This family is characterised by the fact that all its members possess spines; but the tail, if at all long, is not prehensile, and the soles of the feet are smooth and not covered with rough tubercles, as in the Tree Porcupines of the next family, Erethizontidae. The clavicle is less developed than in the arboreal forms. In the organs of digestion there are points of a family difference between the two groups of spiny Rodents. The tongue has serrated scales arranged in transverse rows, which are directed backwards. A gall-bladder, though not always present, is sometimes found; it apparently never exists in the arboreal Porcupines and in *Erethizon*. The lungs show a great tendency to subdivision, which appears to be especially marked in the genus *Atherura*. The caecum seems also to be shorter in the Ground Porcupines. In *Hystrix cristata* the small intestine measures 15 feet 7 inches; the caecum, 8 inches; the large intestine, 4 feet 4 inches:—in *Atherura africana* the caecum measures 7½ inches; the large intestine, 1 foot 10 inches. The corresponding measurements of *Synetheres villosus* were: small intestine, 7 feet 3 inches; caecum, 1 foot 4 inches; large intestine, 2 feet 7 inches. In *Erethizon* the caecum is 2 feet 4 inches in length. These differences are too large and too constant in a number of presumedly allied forms to be overlooked.

Mr. Parsons has directed attention[1] also to a number of muscular differences, such indeed as might be expected to occur between animals of such different habits.

The genus *Hystrix* embraces the better-known Porcupines. It is a genus of wide range, extending from the East Indies to Africa,

[1] *Proc. Zool. Soc.* 1894, pp. 251, 680.

and even occurring in Europe. There are several species, of which the common *Hystrix cristata* is the best known, and is the one which is to be found in Europe.

The spines of the common form and of the others are solid in the middle of the body, but on the tail they are expanded into hollow quills, which make much rattling. They are as a rule black and white, the middle of the spine being banded with black. A great crest of coarse long hairs on the head is responsible for the scientific name of the well-known form.

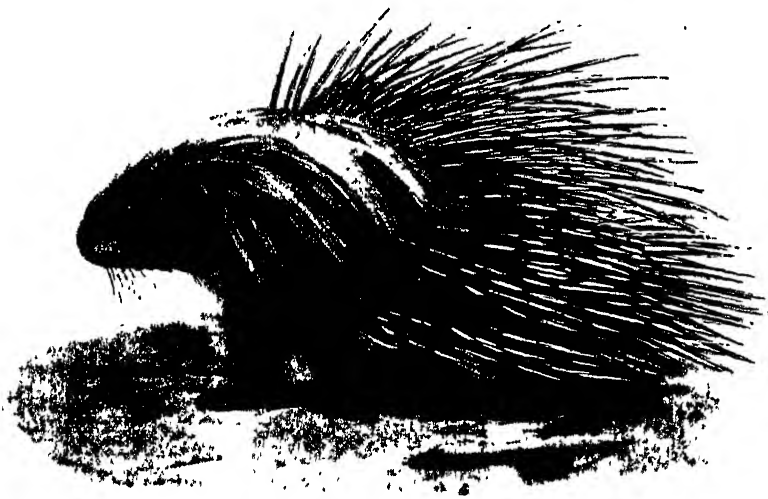


Fig. 245.—Common Porcupine *Hystrix cristata.* $\times \frac{1}{10}$.

Sometimes in this genus, as in the Tree Porcupines of Brazil, the spines are orange or yellow; but it is said that the colour is soon lost in this country. As a matter of fact it is the easiest thing in the world to wash out with ordinary tap-water much of the yellow colour of the spines of the South American *Sphingurus*. The same may be the case with the pigment of the Old-World Porcupines. There are fourteen to fifteen dorsal vertebrae and four or five lumbars. The tail varies in length, but is shorter than the long tail of the arboreal New-World forms. It seems impossible when mentioning the Porcupine to escape from some observations about its alleged habit of shooting its quills. For some reason or other Buffon has got the credit of inventing, or at

least promulgating, this legend, which has even grown so in the telling that the quills are said to be capable of penetrating planks of wood. What Buffon said *apropos* of this matter is, "The marvellous commonly is pleasingly believed, and increases in proportion to the number of hands it passes through." It is of course the rattling of the spines and the occasional falling out of loose ones which has started the legend. They are, however, excellent weapons of offence, and the animal charges somewhat backwards to make the best use of them against the foe. The spines, however, are by no means an absolute protection, since, as Mr. Ridley informs us,[1] Tigers will kill and eat these animals just as the Thylacine is apparently indifferent to the spiny armature of *Echidna*.

Of the Brush-tail Porcupine, *Atherura*,[2] there are at any rate two species, the West African *A. africana* and the Malayan *A. fasciculata*. It is interesting that the gap in the present distribution is partially filled by the discovery of fossil teeth near Madras. The genus does not differ widely in external appearance from *Hystrix*; it has, however, a rather longer tail; there are fewer large spines, and there is a tuft of them at the end of the tail, whence is derived the name of the genus. The frontal bones project a little distance between the nasals, a feature which does not seem to appear in the true Porcupines. There are fourteen dorsal vertebrae and five lumbars. The twenty-four caudal vertebrae of this Porcupine shows how much longer is its tail than that of *Hystrix*; for in the latter twelve is about the number.

A third genus of Old-World Porcupine is the singular *Trichys*.[3] Of this there is but one species, *T. lipura*. It is a curious fact that out of three examples, all from Borneo, two were quite without a tail. But this appears to be merely a mutilation, though it is singular that the natives state it to be without a tail. One cannot help thinking of the way in which lizards sometimes shed their tails when pecked at. The tail of this genus is more than half the length of the body and head. *Trichys* has sixteen dorsal and six lumbar vertebrae. There is a tuft of quills at the end of the tail, which are thin and compressed,

1 *Nat. Science*, vi. 1895, p. 94.

2 See Parsons. *Proc. Zool. Soc* 1894, p. 675.

3 Günther, *Proc. Zool. Soc.* 1876, p. 739, and 1889, p. 75; and Cederblom, *Zool. Jahrb. Syst. Abth.* xi. 1897-98, p. 497.

though truncate at the free extremity and hollow; they represent in a more rudimentary way the much stronger tuft at the end of the tail of other Porcupines. It is a curious fact that this and other Porcupines possess a mechanism for warning their foes precisely comparable to that of the rattlesnake. There are sixteen dorsal vertebrae

SUB-ORDER 2. DUPLICIDENTATA.

The chief feature of this group is the existence of two pairs of incisor teeth in the upper jaw, of which the inner are very small and lie behind the outer. In the skull the infra-orbital foramen is small; the incisive foramina are very large. The tail is short or absent.

Fam. 1. Leporidae.—This family is distinguished from the Lagomyidae by the long ears, by the tail, which is present, though short, and by the longer limbs. There are six teeth belonging to the molar series in the upper jaw, and five of the same in the lower. The clavicle is imperfect.

The longest known genus of this family, *Lepus*, was, until the quite recent discovery of *Romerolagus*, the only genus. It is of universal range, excepting Australasia and Madagascar, and consists of about sixty species. These are the Hares and Rabbits, to the former being assigned the longer-limbed forms.

As every text-book of zoology contains a more or less elaborate account of the structure of the Common Rabbit, and as there is but little structural difference between the members of the genus, a short account of the generic peculiarities of *Lepus* will suffice here. The fore-feet are five-toed, the hind-limbs four-toed. The hairy integument enters the mouth cavity, and the inside of the cheeks have a hairy covering. The soles of the feet are, moreover, hairy. The maxillary bones are curiously sculptured.

The Common Rabbit, *L. cuniculus*, differs from the Common Hare in the comparatively shorter ears and legs. The ears have not, to so marked a degree, the black tips of those of the Hare. The animal, moreover, produces naked young, and lives in burrows of its own excavation. A difference in the structure of the caecum, which distinguishes the Rabbit from the Hare, has been

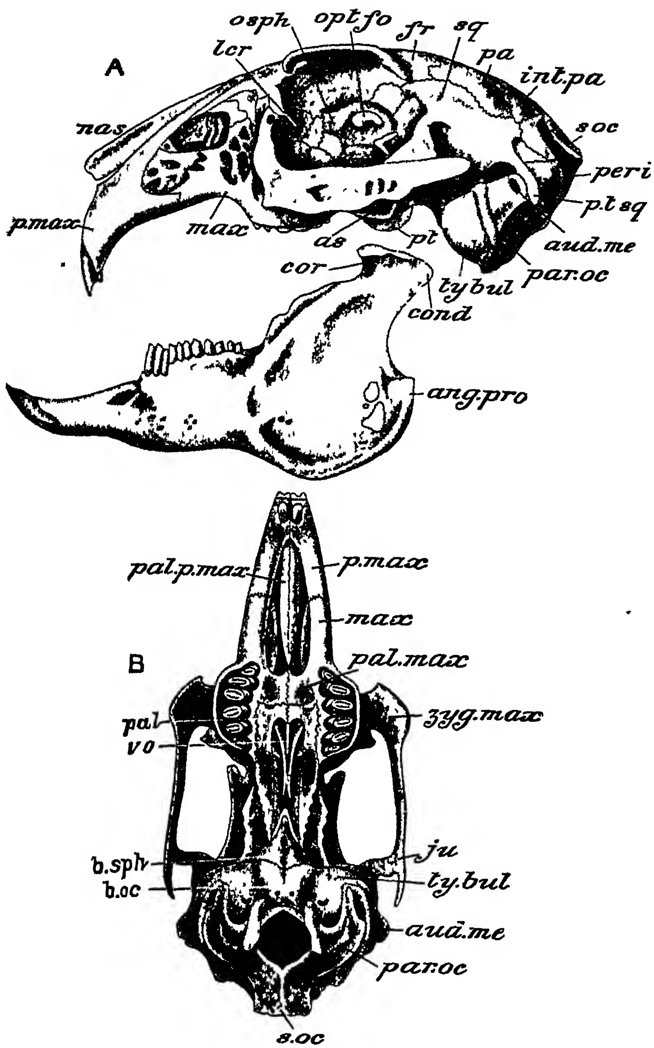


FIG. 246.—*Lepus cuniculus.* Skull. **A**, Lateral view; **B**, ventral view. *ang pro,* Angular process of mandible; *as*, alisphenoid (external pterygoid process); *aud.me,* external auditory meatus; *b.oc,* basioccipital; *b.sph,* basisphenoid; *cond,* condyle; *cor,* coronoid process; *fr,* frontal; *int.pa,* inter-parietal; *ju,* jugal, *lcr,* lachrymal; *max,* maxilla; *nas,* nasal; *opt.fo,* optic foramen; *o.sph,* orbitosphenoid, *pa,* parietal; *pal,* palatine; *pal.max,* palatine plate of maxilla; *pal.p.max,* palatine process of premaxilla; *par.oc,* paroccipital process; *peri,* periotic; *p.max,* premaxilla; *pt,* pterygoid; *p.t.sq,* post-tympanic process of squamosal; *s.oc,* supraoccipital, *sq,* squamosal; *ty.bul* tympanic bulla; *vo,* vomer; *zyg.max,* zygomatic process of maxilla. (From Parker and Haswell's *Zoology.*)

pointed out by Professor W. N. Parker.[1] These differences have led some to approve of its separation from the Hares into a genus *Oryctolagus*. This animal is believed to be an introduced species, and to have been brought by man into these islands. Its original home is the Spanish Peninsula, the south of France, Algiers, and some of the Mediterranean islands. Mr. Lydekker thinks that the only other species of *Lepus* which can be considered to be a "Rabbit" is the Asiatic *L. hispidus*.

Of Hares there are two species in this country. The Common Hare, *L. europaeus* (the name *L. timidus* seems to be really applicable to another species to be referred to presently), extends all over Europe excepting the extreme north of Russia and Scandinavia. It is not known in Ireland, and, curiously enough, attempts to acclimatise this animal in that island have failed—a state of affairs which contrasts with the fatal ease with which the Rabbit has been introduced into Australia. Ireland has, however, the Variable Hare, *L. timidus* (also called *L. variabilis*), a species which is common in other parts of Europe, and which extends as far east as Japan. This species differs from its ally by the fact that it often turns white in winter with the exception of the black tips to the ears. In Ireland this change does not always occur, but Mr. Barrett-Hamilton has commented upon the fact that Hares of this species do change on Irish mountains. It appears that in this animal the change from the winter to the summer dress is accomplished by the actual casting off of the white hairs and their replacement by a fresh growth of "blue" hairs. A similar change occurs in the American *L. americanus*.

Dr. Forsyth Major has noted the fact that the various species of Hares can be distinguished by the condition of the furrows upon the upper incisors. Thus two African species, *L. crawshayi* and *L. whytei*, are to be separated by the fact that in the former the incisors are quite flat, whereas in *L. whytei* the groove is more prominent and there is a second shallow furrow.

The genus *Romerolagus*[2] is quite a recent discovery. It occurs on the slopes of Popocatepetl in Mexico; it has the general aspect of the last genus, and is spoken of as a "Rabbit." It inhabits runs in the long grass which clothes the sides of the

[1] *Proc. Zool. Soc.* 1881, p. 624.
[2] *Proc. Biol. Soc. Washington*, x. 1896, p. 169.

mountain. Externally it is something like the Pikas, since it has no tail visible. The ears, too, are short, and the hind-legs comparatively short. The skull is very like that of the Rabbit; but in other osteological details it is aberrant. Thus the clavicle is quite complete, and only six ribs articulate with the sternum, instead of the seven that we find in the Rabbit.

Fam. 2. Lagomyidae.—The animals of this family are smaller than the Hares and Rabbits; they have short Vole-like ears and no external tail. The limbs also appear to be shorter. As there is but a single genus, the characters of the family may be described in connexion with those of the genus, which is known as *Lagomys* (apparently more correctly *Ochotona*). Of this genus there are about sixteen species, which are mainly Asiatic; one species extends its range into Eastern Europe, and three are North American.

The skull has not the supra-orbital grooves of the Rabbits, and has a well-marked backward process of the zygomatic arch. There are eighteen dorsal vertebrae. The molars and premolars are five.

The vernacular names of "Pika" and "Piping Hares" have been applied to the members of this genus, the latter on account of their peculiar call. They live among rocks in companies and they burrow. They are usually found at considerable altitudes: thus *L. roylei*, the "Himalayan Mouse Hare," is found at elevations as high as 16,000 feet; while *L. ladacensis* gets even higher, 19,000 feet having been recorded. With the habits of a Marmot, so far as concerns living in burrows and at great altitudes, the animals of this genus, with their squat form and short ears, are not unlike those animals. In the past this genus occurred more generally over Europe. Species from Miocene beds have been met with in England, France, Germany, and Italy.

Fossil Rodents.—Quite a large number of existing genera of Rodents are known from even the earlier strata of the Tertiary period. The Squirrels (and even the genus *Sciurus* itself) occur in the Upper Eocene. So, too, do the genera *Myoxus*, and (in South America) *Lagostomus*. *Spermophilus*, *Acomys*, *Hystrix*, *Lagomys*, *Lepus*, *Hesperomys* are known from Miocene rocks. *Rhizomys*, *Castor*, *Cricetus*, *Mus*, *Microtus*, and some others appear to have originated so far as we know in the Pliocene, while a still larger series of existing genera are Pleistocene. It is interesting

to note that some of the extinct genera were much larger than recent forms. At present, *Hydrochoerus* is the biggest Rodent; but the genus *Megamys* from the Pampas formation of Argentina was "nearly as large as an ox." The wider range of genera in the past is illustrated by *Hystrix*, which, now an Old-World form, is represented by remains in the Miocene and Pliocene of America.

It is a significant fact that of living genera *Sciurus* is the oldest; for it has been pointed out that in a number of features the Squirrels are among the most primitive of Rodents. The zygomatic arch is slender, and has thus not acquired the specialisation that is to be found in that part of the skull in other Rodents; moreover, the "jugal bone is not supported by any process from the maxilla exactly as in the primitive Ungulata." The feet, too, are unspecialised, though that is the case with many other genera. It may also be pointed out that the teeth bear not a little likeness to those of *Ornithorhynchus* in their multituberculate character.

Some few fossil forms have already been dealt with in the preceding pages.

The two genera *Castoroides* and *Amblyrhiza*, from the Pleistocene of North America and the West Indies, are usually regarded as forming a family. The skull of the former genus indicates an animal of the size of a Bear. It is compared to that of *Castor*, but it has a wide infra-orbital foramen. The teeth are four in each jaw, and are formed of three to five lamellae; the incisors of this animal are powerful but short. *Amblyrhiza*, on the other hand, has long incisors which are longitudinally grooved anteriorly. It has a free fibula. This latter as well as other characters have led Tullberg to remove it from association with *Castoroides*.

Order X. TILLODONTIA.

This group of Eocene mammals is to be defined by a number of characters, of which the more important are the following:—The incisors are enlarged, grow from persistent pulps, and are coated with enamel upon the outer surface only; they are those of the second pair only, the first and third having disappeared or become small. The canines are reduced in the later forms.

These animals have been regarded as ancestral Rodents, to which the tooth characters just mentioned clearly show likenesses. The earliest known form is *Esthonyx*. This genus shows

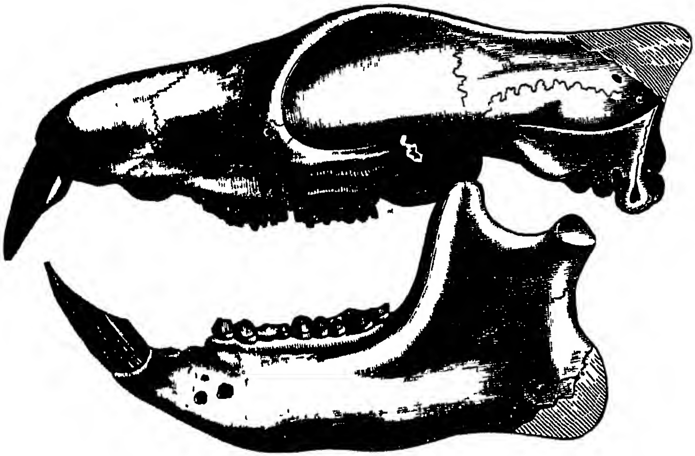


FIG. 247.—*Tillotherium fodiens*. Left lateral view of skull. (From Flower, after Marsh.)

such primitive characters, compared with its later representatives, as the existence of all three pairs of incisors in the upper jaw, but only two in the lower jaw. The enlarged incisors of both jaws do not seem to have grown from persistent pulps.

Anchippodus, a later form, still preserves the upper pair of first incisors in a vestigial form; the strong second incisors grew from persistent pulps. The most recent genus, *Tillotherium*, shows the characteristics of the group at their height. The strong Rodent-like, chisel-shaped incisors, which are reinforced by a small additional pair in the upper jaws only, are persistent. The grinding teeth are of the trituberculur pattern; there are three of each kind in the upper jaw, but in the lower jaw only two premolars on each side. This is at any rate the case with some, while others have three. The canine, though present in both jaws, is insignificant. As in many ancient types, there is an entepicondylar foramen in the humerus. The feet were five-toed, and bore sharp, laterally-compressed claws. The skull has been compared in general aspect to that of a Bear.

CHAPTER XVI

INSECTIVORA—CHIROPTERA

Order XI. INSECTIVORA.

THE Insectivora[1] are an order of mammals to which it is (to quote Professor Huxley) "exceedingly difficult to give a definition." They are, however, none of them large animals, and most of them are nocturnal in habit—two circumstances which may have had something to do with their survival from past ages, as may have also their modification to so many and diverse modes of life; for everything points to the antiquity of the group. They are, for instance, more or less plantigrade. The snout is generally long, and is often prolonged into a short proboscis.[2] There is a tendency for the teeth to be of a generalised type, and their number is often the typical mammalian forty-four. Moreover, trituberculate teeth, which are certainly an ancient form of tooth, are common; and indeed the Insectivora of the southern regions of the globe, *e.g.* Centetidae, Solenodontidae, and Chrysochloridae, have the most prevalent trituberculism, a fact which is of importance in considering the age of the animal life of these regions of the world. The limbs are, as a rule, provided with five digits. The hemispheres of the brain are usually smooth, and do not extend over the cerebellum. The palate is often fenestrate as in the Marsupials, and as in that group the lower jaw is sometimes inflected. But the latter character also occurs in the Sea-lions and elsewhere. Clavicles are present, as a rule, but not in *Potamogale*.

[1] See especially Dobson, *A Monograph of the Insectivora*, London, 1886-90.

[2] Even in the Otter-like *Potamogale* the upper jaw, though broad and flat, projects considerably beyond the lower.

There is, furthermore, a distinct tendency towards a disappearance of functional milk teeth, which is best seen in *Sorex*, where there are only seven milk teeth, none of which ever cut the gum. This suppression of the milk dentition is like that of the Marsupials, Edentates, and Whales, all of which appear to be—the first certainly are—ancient forms of mammalian life.

There is also a fairly well-defined, though shallow, cloaca in many genera. Finally, the testes are purely abdominal in some, and in none is there a full descent into a scrotum, as in the more highly-developed Eutheria.

SUB-ORDER 1. INSECTIVORA VERA.

Fam. 1. Erinaceidae.—This family contains the genera *Erinaceus*, *Hylomys*, and *Gymnura*.

Hylomys, considered by Dobson to fall within *Gymnura*, is kept separate by Leche.[1] *H. suillus* is a Malayan animal, small in size, about 5 inches long, with a short tail. Like *Gymnura* it is spineless. The ears are decidedly large and nude. There is one pair of inguinal and one pair of thoracic teats. The colour above is a rusty brown with yellowish-white under parts. The palms and soles are quite naked. In its general form it recalls *Tupaia* very much more than its own immediate relatives. There is no doubt, however, of its systematic position when the skeleton and teeth are examined. A variety has been described from altitudes of 3000 to 8000 feet on Mount Kina Balu in Borneo It has the complete dentition of forty-four teeth. There are fourteen pairs of ribs. As in *Gymnura* the tibia and fibula are united below. The genus is considered by Leche to be the oldest existing type of Erinaceidae.

Gymnura[2] is also a Malayan form with the complete dentition of the last, but with fifteen pairs of ribs and a longer tail, consisting of twenty-three vertebrae as against fourteen. There is, as with *Hylomys*, but one species, *G. rafflesii*. This animal has a peculiar odour, resembling decomposed cooked vegetables.

[1] "Bemerkungen über die Genealogie der Erinaceen." In *Festschrift f. Liljeborg*, 1896. See also Anderson, *Trans. Zool Soc.* viii. 1874, p 453.

[2] Dobson, "Notes on the Anatomy of the Erinaceidae," *Proc. Zool. Soc.* 1881, p. 389.

The under surface of the tail is rough, and it is thought by Dr. Blanford that it may be of use to the animal in climbing Its compressed terminal third and the fringe of stiff bristles on the under surface of this indicate, according to Dr. Dobson, powers of swimming, or at any rate a not very remote ancestry of swimming creatures. It is purely insectivorous in diet.

Erinaceus, including the Hedgehogs, is a widely distributed genus—Palaearctic, Oriental, and Ethiopian in range. There are about twenty species. The familiar spines distinguish the Hedgehogs from their allies, as also the fact that they possess but thirty-six teeth, the formula being I $\frac{3}{2}$ C $\frac{1}{1}$ Pm $\frac{3}{2}$ M $\frac{3}{3}$. There are fifteen or fourteen ribs, and the tail is very short, consisting of only twelve vertebrae. As in *Gymnura* there is no caecum. The upper canine has usually, as in other Erinaceidae, two roots, but not in *E. europaeus*, which is one of the most modified of Hedgehogs.

The Hedgehog is a more omnivorous creature than *Gymnura*. It eats not only insects and slugs, but also chickens and young game birds, and lastly vipers. Four, or in some cases as many as five or six, young are produced at a birth; they are blind, with soft and flexible white spines. In hot and dry weather Hedgehogs disappear; they come forth in rainy weather. The English Hedgehog, as is well known, hibernates. The Indian species do not. The Hedgehog is occasionally spineless, which condition may be regarded as an atavistic reversion.[1]

The Hedgehog has acquired the reputation of carrying off apples transfixed upon its spines. Blumenbach thus quaintly describes this and other habits of the animal, whose English name he gives as "hedgidog": "Il se nourrit des productions des deux règnes organisés, miaule comme un chat, et peut avaler une quantité énorme de mouches cantharides. Il est certain qu'il pique les fruits avec les épines de son dos, et les porte ainsi dans son terrier."[2]

The Miocene *Palaeoerinaceus* is so little different from *Erinaceus* that it is really hardly generically separable. *Erinaceus* is therefore clearly one of the oldest living genera of mammals.

Necrogymnura of the same epoch and the same beds (Quercy Phosphorites) is doubtless an ancestral form. The palate is

[1] See *Natural Science*, xiii. 1898, p. 156.
[2] *Manuel d'Hist. Nat.* French trans. by Artaud, 1803.

perforated as in *Erinaceus* (it is not so in *Gymnura* and *Hylomys*), but on the whole it comes nearest to *Hylomys*.

Fam. 2. Tupaiidae.—This family contains the genera *Tupaia* and *Ptilocercus*. *Tupaia* is Oriental in range, extending as far east as Borneo. There are a dozen or so of species, which are generally arboreal and have the outward aspect of Squirrels. It has been suggested that this is a case of mimicry, the animal gaining some advantage by its likeness to the Rodent. The name Tupaia, it should be added, means Squirrel, and the long-nosed Squirrel, *Sciurus laticaudatus*, is so extraordinarily like it that "one has to look at the teeth" to distinguish them. Moreover, this Squirrel, like some Tupaias, lives largely on the ground among fallen logs. *Tupaia* resembles a Lemur in the complete orbit. The dental formula is I $\frac{2}{3}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{3}{3}$ = 38. The sublingua, too, is stated by Garrod to be like that of *Chiromys*. There is a minute caecum in *T. belangeri*, none in *T. tana*.

Ptilocercus[1] has a pen-like posterior portion to the tail, a modification which is found in other groups of animals. The tail of certain Phalangers, for instance, shows this same modification. The rest of the tail is scaly. The animal, as was pointed out by Dr. Gray,[2] looks very much like a Phalanger. The orbit is entire as in *Tupaia*. The fingers and toes are five. The one species, called after Sir Hugh Low, G.C.M.G., *P. lowi*, is a Bornean animal.

Fam. 3. Centetidae.—This family is entirely confined to the Island of Madagascar. It includes some seven genera. The best-known genus is *Centetes*. *C. ecaudatus*, the Tanrec, Tenrec, or Tendrac, is an animal a foot or so in length, without a tail, and with forty-four teeth.[3] The immature animal is so different from the parent as to appear quite a different form. It has three narrow rows of spines along the back, which do not wholly disappear until the permanent dentition has been acquired. Even then the hairs are of a rather spiny character, particularly those upon the back of the head, which are erected when the animal is

[1] "Notes on the Visceral Anatomy of the Tupaia of Burmah," *Proc. Zool. Soc.* 1879, p. 301.

[2] *Proc. Zool. Soc.* 1848, p. 23.

[3] I quote Woodward, *Proc. Zool. Soc.* 1896, for this dentition. The fourth molar of the lower jaw is not always present. It comes late, and only *old* animals possess it.

annoyed. The Tanrec feeds mainly upon earthworms. It is "probably the most prolific of all animals," since as many as twenty-one young are said to have been brought forth at a birth. Some Opossums, however, have twenty-five teats.

Hemicentetes[1] is a genus with two species. These have spines mixed with the fur of the back. There is no caecum in this or

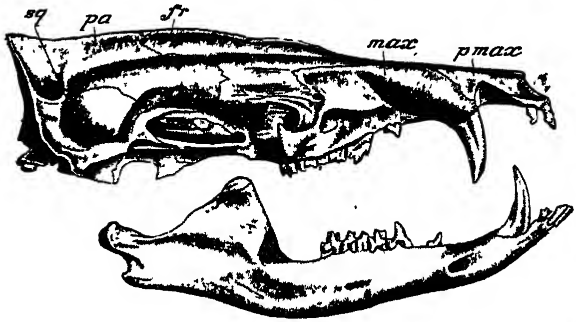


FIG. 248.—Skull of Tenrec. *Centetes ecaudatus*. *fr*, Frontal; *max*, maxilla; *pa*, parietal; *p.max*, premaxilla; *sq*, squamosal. (After Dobson.)

in other Centetidae. The teeth are forty in number, there being only three molars.

Ericulus setosus is a small Insectivore, resembling externally a small Hedgehog. It is covered with close-set spines which, unlike what is found in *Erinaceus*, extend over the short tail. The total number of teeth is thirty-six, the formula being I $\frac{2}{2}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{3}{3}$.

Echinops[2] is another spiny genus which is a stage in advance of *Ericulus*, for still another molar has been lost, reducing the total number of teeth to thirty-two. The dental formula is thus I $\frac{2}{2}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{2}{2}$. The zygomata are reduced to mere threads.

Microgale, a genus recently instituted by Mr. Thomas, is a small furry Insectivore with a long tail, which is more than double the length of the head and body. There are no less than forty-seven vertebrae in the tail, which is relatively longer than that of any other mammal.

Limnogale, discovered by Forsyth Major, is an aquatic genus, also furry and not spiny, which has departed from the Centetid type and taken to an aquatic life. The single species,

[1] Mivart in *Proc. Zool. Soc.* 1871, p. 58.
[2] Thomas, *Proc. Zool. Soc.* 1892, p 500.

L. mergulus, is about the size of *Mus rattus*; it has webbed toes and a powerful laterally-compressed tail. Clavicles are present, which is not the case with *Potamogale*.

Oryzoryctes is a Mole-like Centetid. It has fossorial fore-limbs, but a fairly long tail. This genus is furry like the last two. It is said to burrow in the rice-fields and to do much harm. The teeth are forty in number, three incisors and three molars in each half of each jaw.

Fam. 4. Potamogalidae.—This family contains two genera, *Potamogale* and *Geogale*.

Potamogale velox is a West African animal, which though an Insectivore has the habits of an Otter. It is "somewhat larger than a stoat." The upper surface of the body is dark brown, the belly brownish yellow. It has a flat head and a long tail like the Stoat, but the tail is laterally compressed and very thick. The eyes are very small; the nostril has valves. The toes are not webbed, but the second and third toes are united for the whole length of their first phalanges. Along the outer side of the foot is a thin extension of the integument. In swimming the feet are drawn up along the body, hence webbing would be of no use; but the thin flattening prevents the edge of the foot from acting as a hindrance to the motion of the animal. M. du Chaillu describes it as catching fish, which it pursues with extreme rapidity in the clear mountain streams it frequents; but Dr. Dobson, remarking that no stomachs have been examined, thinks that water insects are more probably its prey. It is not known whether the animal possesses a caecum. The tooth formula[1] is $I\,\frac{3}{3}\ C\,\frac{1}{1}\ Pm\,\frac{3}{3}\ M\,\frac{3}{3}$. The animal is exceptional among the Insectivora in having no clavicles.[2] There are sixteen ribs; there is no zygomatic arch, and the pterygoids converge posteriorly.

Geogale, with one species, *G. aurita*, is a small representative of this family from Madagascar. It has only thirty-four teeth. When better known it may be necessary, thinks Mr. Lydekker, to make this animal the type of a separate family. The tibia and fibula are distinct, not confluent with one another as in *Potamogale*.

Fam. 5. Solenodontidae.—This family contains but a single genus.

[1] Allman states the canines to be absent. I follow Flower and Lydekker.

[2] See Allman in *Trans. Zool. Soc.* vi. 1869, p. 1.

Solenodon. This genus, including two species, one from Cuba, the other from Hayti, was at one time referred to the Centetidae. It offers, however, numerous points of difference from the members of that family with some general points of agreement. Possibly its isolation in the two West Indian islands mentioned is comparable to the isolation of the Centetidae in Madagascar; they are both survivors of an ancient group of Insectivores extinct elsewhere. *Solenodon* has nearly the complete dentition. It has lost only one premolar, and has therefore forty teeth in all. The formula is thus I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{3}{3}$. It also differs from the Centetidae in having only two inguinal mammae instead of both inguinal and thoracic; the penis of the male does not project from a cloaca, but lies forward. On the other hand, the molars have their cusps arranged in the V-fashion of the Centetidae, a fact, however, which, in the opinion of some, merely points to an ancient trituberculism not indicative of special affinity. It has, moreover, no zygoma in the skull, and there is no caecum. Dr. Dobson has furthermore tabulated a number of differences in muscular anatomy between the two families. *Solenodon* has a long naked tail. The snout, always developed in Insectivores, is extraordinarily long in this genus. It is a furry, not a spiny animal. *S. cubanus* is liable to fits of rage when irritated, a feature which it has in common with Shrews and Moles; it is also stated to have the ostrich-like way of concealing its head in a crevice, "apparently thinking itself then secure." But nothing is known of the genus in a wild state.

Fam. 6. Chrysochloridae.—This family contains only the genus *Chrysochloris*, comprising some five species, all natives of Africa south of the equator. The scientific name of the genus, and also the vernacular name Cape Golden Mole, are derived from the beautiful iridescent hairs which are intermingled with softer and non-iridescent fur. *Chrysochloris* has V-shaped cusped teeth like those that are possessed by the Centetidae and Solenodontidae. In the skull as in the Macroscelidae, etc., but not in the Centetidae, there are complete zygomata. They are Moles in habit, and the eyes are covered with skin; the ears, moreover, have no conches. The teeth are forty or thirty-six in number, the reduction being caused by the losing of a molar in those forms which possess the smaller number.[1] It is interesting to notice that the adapta-

[1] The generic name of *Chalcochloris* was proposed by Dr. Mivart for these.

tion to a digging life is brought about in quite a different way from that of the true Moles (*Talpa*). In the latter the fore-limbs are changed in position by the elongation of the manubrium sterni, carrying with it the clavicles, which are extraordinarily shortened (Fig. 251). In *Chrysochloris*, on the other hand, the same need (*i.e.* that the limbs project as little as possible from the sides of the body, while the length of the limbs is retained, and the leverage of the muscles unaffected) is provided for by a hollowing

FIG. 249.—Golden Mole. *Chrysochloris trevelyani.* A, Lower surface of fore-foot. × ½. (After Gunther.)

out of the walls of the thorax, the ribs and the sternum being here convex inwards. The sternum and the clavicles are not modified. The tibia and fibula are ankylosed below. In the manus, moreover, there are but four digits, of which the two middle ones are greatly enlarged. In the Moles there are five fingers, and all are enlarged; there is, too, a great radial sesamoid bone, which is as good as a sixth finger (which, indeed, it is considered to be, in common with similar structures in other animals, by some anatomists). The foot has only four toes.

Fam. 7. Macroscelidae.[1]—This family contains three genera, all of them African in range, and mainly Ethiopian.

Macroscelides, the Elephant Shrews, are jumping creatures of Shrew-like appearance, combined with a Marsupial look. Both radius and ulna, and tibia and fibula, are ankylosed. There

[1] See Peters, *Reise nach Mosambique*, 1852, for external characters and anatomy.

are five fingers and toes. There is a caecum as in but few Insectivores. The tooth formula, as revised by Thomas,[1] is I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{2}{2 \text{ or } 3}$, the total number being thus forty or forty-two. There are several species of this genus.

FIG. 250.—*Rhynchocyon chrysopygus.* × $\frac{1}{4}$ (After Gunther.)

Rhynchocyon and *Petrodromus* differ from *Macroscelides* in not having such long hind-legs. The dental formula of the first is I $\frac{1 \text{ or } 0}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{2}{2} = 34$ or 36, of the latter I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{2}{2} = 40$. In *Petrodromus* the toes are reduced to four; in *Rhynchocyon* there are only four digits in the manus as well as in the pes. This animal, as its name implies, has a longish proboscis, which can be bent, and is really very like a miniature Elephant's trunk, and also like that of the Desman (*Myogale*). It has thirteen pairs of ribs, and a well-developed caecum. Dr. Günther has pointed out that in *Petrodromus tetradactylus* the hairs of the lower part of the tail are stiff elastic bristles 5 mm. long, with a swelling at the free tip. The use of this singular modification is not at all apparent. *Pseudorhynchocyon*, of European Oligocene, is believed to be related to this family.

Fam. 8. Talpidae.—This family is confined to the Palaearctic and Nearctic regions, or practically so, being fairly equally dis-

[1] "Mammals collected by Dr. Emin Pasha," in *Proc. Zool. Soc.* 1890, p. 446.

tributed as regards genera; a Mole just gets over the boundary into the Oriental region. The genus *Talpa* is entirely Old World in range, and includes several species, of which the Common Mole, *T. europaea*, is the best known. There are forty teeth, one of the molars of the full mammalian dentition not being represented. In the milk dentition there is an additional premolar, not repre-

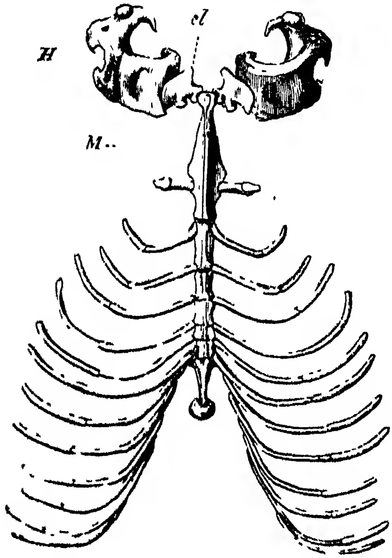


FIG. 251. Sternum and sternal ribs of the Common Mole (*Talpa europaea*), with the clavicles (*cl*) and humeri (*H*); *M*, Manubrium sterni. Nat. size. (From Flower's *Osteology*.)

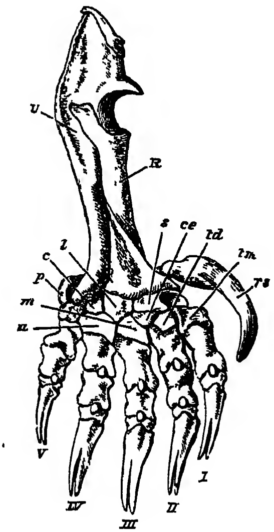


FIG. 252.—Bones of fore-arm and manus of Mole (*Talpa europaea*). × 2. *C*, Cuneiform; *ce*, centrale; *l*, lunar; *m*, magnum; *p*, pisiform; *R*, radius; *rs*, radial sesamoid (falciform); *s*, scaphoid; *td*, trapezoid; *tm*, trapezium; *U*, ulna; *u*, unciform; *I*-*V*, the digits. (From Flower's *Osteology*.)

sented by a successor in the permanent dentition. The formula is thus I $\frac{3}{3}$ C $\frac{1}{1}$ Pm $\frac{4}{4}$ M $\frac{3}{3}$. There are no external ears, and the eyes are rudimentary; the soft silky fur is familiar to everybody. The sternum has a strong crest, associated with a powerful development of the pectoral muscles, so necessary to a burrowing animal. The animal, it is hardly necessary to state, lives underground in burrows excavated by itself, which have not, it has been stated, the elaborate and, it appears, fanciful shape assigned to them by many writers. At times Moles appear above ground.

Their principal food consists of earthworms, and it may not be out of place to quote Topsell's quaint account of their pursuit of the annelids: "When the wormes are followed by molds (for by digging and heaving they foreknow their owne perdition) they fly to the superficies and very toppe of the earth, the silly beast knowing that the molde, their adversary, dare not followe them into the light, so that their wit in flying their enemy is greater than in turning againe when they are troade upon." It has lately been said[1] that Moles store up earthworms for consumption during the winter, biting off their heads to prevent their crawling away.

Scalops, an American genus, is a Mole-like creature of largely aquatic habits, as its webbed hind-feet show; it has a short, naked tail. Apparently, like the Shrews, it has no lower canines.

Condylura, another American genus, is called the Star-nosed Mole on account of a curious radiating structure at the end of the snout.

Myogale, the Desman, is still more aquatic in habit, and connects the Moles with the Shrews, though, as in many of the former, it has lower canines. It has webbed hind-feet and a long tail. One species occurs in the Pyrenees, the other in Russia. A few other genera (*Urotrichus, Uropsilus, Scaptonyx, Dymecodon, Scapasius, Perascalops*) belong to the same family.

Fam. 9. Soricidae.—The true Shrews have a much wider range than other families of the present order. In the Palaearctic region are found *Sorex, Crossopus, Crocidura, Nectogale, Chimarrogale.* The first is also Nearctic, and reaches Central America In the Ethiopian region is the single peculiar genus *Myosorex*, but *Crocidura* occurs there also. *Blarina* and *Notiosorex* are "Sonoran" in range; *Soriculus* Oriental. *Crocidura, Anurosorex*, and *Chimarrogale* also enter this region. *Sorex* has teeth tipped with reddish colour, its dental formula being, according to Mr. Woodward's recent researches, $I\,\frac{3}{2\text{ or }3}\ C\,\frac{1}{0}\ Pm\,\frac{3}{1}\ M\,\frac{3}{3} = 32$ or 34.

As compared with other Insectivores, therefore, the most remarkable fact found throughout the family is the absence of the lower canines. In addition to this the genus may be known—the family indeed—by the large size of the first pair of incisors. In the above formula it is possible, thinks Mr. Woodward, that there may be errors; he is not certain whether the supposed

[1] Ritsema Bos, *Biol. Centralbl.* xviii. 1898, p. 63.

upper canine may not be a fourth incisor, and whether the first premolar may not be really the canine. Another peculiar feature about the dentition of *Sorex* is the suppression of the teeth of the milk dentition, which are functionless, and probably uncalcified. The genus *Sorex* is terrestrial. The tail is long and covered with hairs. There are two species in this country, *S. vulgaris* and *S. minutus*. The former is the Shrew of legend and superstition; and it is no doubt the species that has lent its name to the more untameable members of the softer sex, though it is the males which are especially pugnacious. As to legend, everybody has heard of the shrew ash whose leaves, after a Shrew has been inserted living into a hole cleft in the tree, are a specific for diseases of cattle, caused by the Shrew itself creeping over them.

The Rev. Edward Topsell, author of *The Historie of Four-footed Beastes*, who defends his veracity by asserting that he does not write "for the rude and vulgar sort, who being utterly ignorant of the operation of learning, do presently condemne al strange things," says of the Shrew that "it is a ravening beast, feigning itself gentle and tame, but, being touched, it biteth deep and poysoneth deadly. It beareth a cruel minde, desiring to hurt anything, neither is there any creature that it loveth, or it loveth him, because it is feared of all." It is probable that all this rustic feeling is due to the powerful effluvium which the Shrew undoubtedly emits.

S. minutus has the distinction of being the smallest British mammal; it is scarcer than the last. This form is found upon the Alps, as is also the peculiarly Alpine species *S. alpinus*, which inhabits the Alps, Pyrenees, Carpathians, and the Hartz.

Crossopus fodiens, the Water Shrew, has also brown-stained teeth. It is not uncommon in this country, and lives in burrows excavated by the sides of the streams which it affects.

Besides these two genera, *Soriculus*, *Blarina*, and *Notiosorex* have red-tipped teeth. In *Crocidura*, *Myosorex*, *Diplomesodon*, *Anurosorex*, *Chimarrogale*, and *Nectogale* the teeth are white-tipped. These are all the genera of the family allowed by the late Dr. Dobson in a review of that family.[1]

Chimarrogale and *Nectogale* are aquatic genera. The former

[1] "A Synopsis of the Genera of the Family Soricidae," *Proc. Zool. Soc.* 1890, p. 49.

consists of a Himalayan and Bornean, and of a Japanese species, which have not webbed feet, but have a tail with a fringe of elongated hairs.

Nectogale elegans is one of the characteristic animals of the Thibetan plateau. It has webbed feet. The teeth are as in *Chimarrogale* I $\frac{3}{2}$ C $\frac{1}{0}$ Pm $\frac{1}{1}$ M $\frac{3}{3}$.

The other genera are terrestrial in habit.

SUB-ORDER 2. DERMOPTERA.

The family **Galeopithecidae** contains but one genus, which has been at times referred to the Lemurs, to the Bats, or has been

FIG. 253.—*Galeopithecus volans.* × $\frac{1}{3}$. (After Vogt and Specht.)

made the type of a special order of mammals. It is better to regard it as an aberrant Insectivore—so different indeed from other forms that it requires a special sub-order for its reception.

Galeopithecus[1] inhabits the Oriental region. It is a larger animal than any other Insectivore, about the size of a Cat, and has a patagium extending between the neck and the fore-limb, between the fore-limb and the hind-limb, and between the hind-limb and the tail. This patagium is abundantly supplied with musculature, but the fingers are not elongated as in the Bats for its support. In the degree of its development, however, the patagium of this creature is midway between that of *Sciuropterus* on the one hand, and the Bats on the other. It presents many remarkable features in its organisation. The brain is like that of the Insectivora in the exposure of the corpora quadrigemina by the slight extension backward of the cerebral hemispheres; but its upper surface is marked by two longitudinal furrows on each side, a state of affairs (in combination) which is unparalleled among the Mammalia. The teeth are peculiar by reason of the singular "comb-like" structure of the lower incisors. This, however, is an exaggeration of what is to be found in *Rhynchocyon* and *Petrodromus*, while the same style of tooth, though not so highly developed, characterises certain Bats. The Tupaiidae and certain Lemurs show what Dr. Leche regards as the beginning of the same thing. As in *Tupaia* also there is an indication of the characteristically Lemurine sublingua. The stomach is more specialised than in other Insectivores, the pyloric region being extended as a narrowish tube. There is a caecum. A peculiarity of the intestinal tract is that the large intestine is longer than the small.

Order XII. CHIROPTERA.

We may thus define the Bats:—Flying mammals, with the phalanges of the four digits of the hand following the pollex greatly elongated, and supporting between themselves and the hind-limbs and tail a thin integumental membrane, which forms the wing. The radius is long and curved; the ulna rudimentary. The knee is directed backwards, owing to the rotation of the limb outward by the wing membrane. From the inner side of the ankle-joint arises a cartilaginous process, the calcar, which supports the interfemoral part of the wing mem-

[1] Leche, "Über Galeopithecus," *K. Svensk. Ak. Handl.* 1886.

brane The mammae are thoracic; the placenta discoidal and deciduate. The cerebral hemispheres, which are smooth, do not extend over the cerebellum.

This large order of mammals was once placed with the Primates. There is no doubt, however, that they form a perfectly distinct order; no knowledge of fossil forms in any way bridges over the gap which distinguishes them from the highest mammals. The most salient feature in their organisation is clearly the wings. These consist of membrane, an expansion of the integument, provided with nerves, blood-vessels, etc., which mainly lie stretched between the digits 2 to 5. These digits themselves, which are enormously elongated, act like the ribs of an umbrella, and when the wing is folded they come into contact. Besides

FIG. 254.—Barbastelle. *Synotus barbastellus.* × ½. (After Vogt and Specht.)

this part of the flying apparatus there is a tract of membrane lying in front of the arm, which corresponds to the wing membrane of the bird, but which in the Bats takes quite a subordinate place. In the bird, on the other hand, there is a metapatagium, which is the main part of the wing of the Bat. It seems just possible that in *Archaeopteryx* the metapatagium was more Bat-like. Furthermore, a steering membrane, like that which fringes the tail in some Pterosaurians, lies interfemorally in Bats, and includes the whole or a part of the tail. The pollex takes no share in the wing, but projects, strongly armed with a claw, from the upper margin.

The bones of this order of mammals are slender and marrowy, they are thus light, and subserve the function of flight. A most remarkable feature among the external characters of the Bat tribe is the extraordinary and often highly complicated membranes which surround the nostrils. These are at least often

more strongly developed in males than in females, and may perhaps be partly relegated to the category of secondary sexual characters. But it seems that they have also an important tactile function, and enable the creatures to fly without touching bodies which intrude themselves upon their way. The ears, too, are frequently very large, and it may be supposed that the sense of hearing is correspondingly acute. In the common Long-eared Bat of this country, the ears are not greatly inferior in length to the head and body of the animal combined. The ears are of every variety of shape, and offer characters which are valuable in the systematic arrangement of the members of the order.

In the skull of Bats there is very rarely a complete separation between the orbital and temporal fossae; the lachrymal duct is outside the orbit. The tympanics are annular, and in a rudimentary condition. The centra

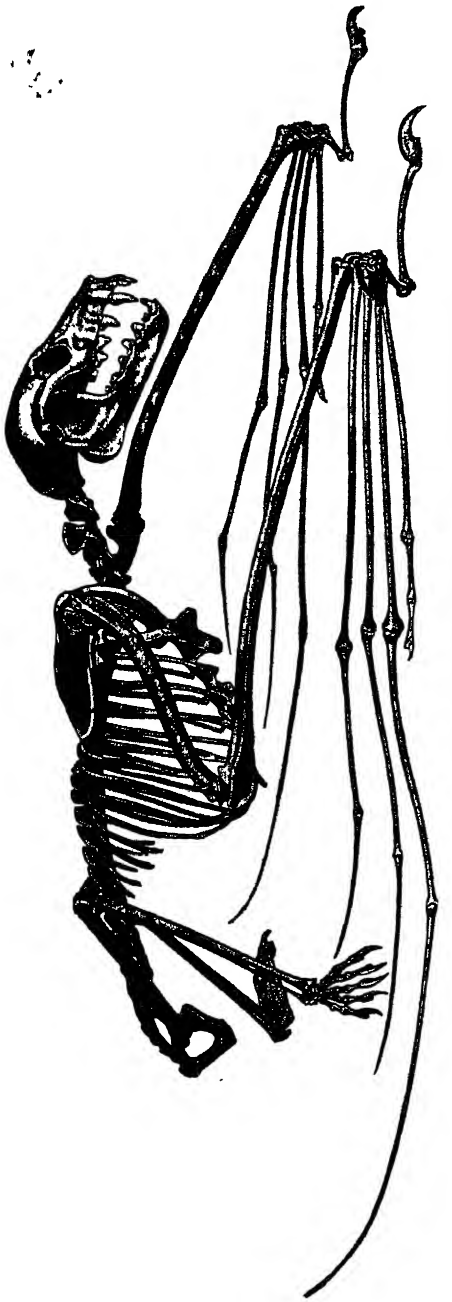


FIG. 255.—Skeleton of Flying Fox. *Pteropus jubatus*. $\times\frac{1}{5}$. (After de Blainville.)

of the vertebrae tend to become ankylosed in old individuals; the caudals have no processes, but are like those quite at the end of the series in long-tailed animals. The sternum is keeled for the better attachment of the pectoral muscles, the chief muscles of flight. The ribs, which are much flattened, are occasionally ankylosed together by their margins. There is a well-developed clavicle. In the carpus the scaphoid, lunar, and cuneiform are all fused together. In the hind-limb the fibula is rarely fully developed.

The Bats are divisible into two primary groups, which are those of the Megachiroptera and the Microchiroptera.

Sub-Order 1. Megachiroptera.

The **Pteropodidae** are frugivorous Bats, usually of large size. The chief distinguishing feature is the fact that the molars are not tubercular, but marked with a longitudinal furrow, which is, however, concealed in the genus *Pteralopex* by cusps. The palate is continued back behind the molars. The index finger has three phalanges, and is usually clawed. The ears

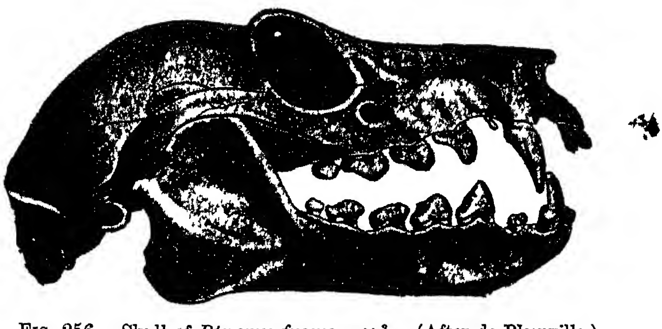


Fig 256.—Skull of *Pteropus fuscus* × ⅘. (After de Blainville.)

are oval, and the two edges are in contact at the base of the ear. The tail, if present, has nothing to do with the interfemoral membrane. This group is entirely Old World in range. The genus *Pteropus* embraces the creatures known as Flying Foxes. They are the largest forms in the sub-order, sometimes having an expanse of wing of 5 feet (this is the case with *P. edulis*). The muzzle is long, and the face therefore "foxy" in appearance.

The inner margin of the nostrils projects, a preparation for the tubular nostrils of *Harpyia.* The tail is absent. The premolars are three and the molars two The pyloric region of the stomach is extended and twisted upon itself. Of this genus there are nearly sixty species, extending from Madagascar to Queensland. Thirty species inhabit the Australian, twenty the Oriental region. Madagascar has seven, and one species just enters the Palaearctic. The occurrence of this genus in India and in Madagascar is one of those facts which favour the view supported, on these and other grounds, by Dr. Dobson and Dr. Blanford, that a connexion between India and Madagascar must once have existed; for these slow-flying creatures could hardly be believed capable of traversing vast stretches of ocean by their unaided efforts.[1]

Pteropus is represented in the Ethiopian region by the allied genus *Epomophorus.* Of this there are perhaps a dozen species.

Fig. 257.—Flying Fox. *Pteropus poliocephalus* × $\frac{1}{8}$.

The teeth are reduced to two premolars in the upper jaw,

[1] See Dobson, *Ann. Nat. Hist.* (5) xiv. 1884, p. 153.

three remaining below, while there is but one molar in each upper jaw, and two in each lower. Dr. Dobson has studied the structure of the remarkable pharyngeal sacs which exist in the neck of the male, and are capable of inflation.

Pteralopex of the Solomon Islands has shorter ears than have many *Pteropus*, otherwise its external characters are the same. As in *Pteropus nicobaricus*, this genus has the orbits shut off by a bony ring, an extremely rare phenomenon in Bats. The canines have two cusps. The characters of the grinding teeth have already been mentioned It is uncertain whether the only species of this genus, *P. atrata*, is, or is not, a vegetable feeder. *Harpyia* has shortish ears and extraordinarily prolonged and tubular nostrils. There is a hint of the accessory cusp to the canines mentioned above in *Pteralopex*. The incisors are reduced to one on each upper jaw, and none below. *Cynopterus* has also often bituberculate canines. It is an Oriental genus with several species.

Nesonycteris, with one species from the Solomon Islands, *N. woodfordi*, has the dental formula I $\frac{2}{1}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{2}{3}$. The index finger has no claw; the tail is absent. The premaxillae are separated anteriorly.

Eonycteris, with a single cave-dwelling species from Burmah, *E. spelaea*, has also no claw upon the index; the tooth formula is fuller by reason of the presence of an additional incisor below. The tongue is very long and is armed with papillae. There is a short but distinct tail.

Notopteris, from New Guinea and the Fiji Islands, is distinguished from the related genera by its long tail.

The remaining genera of Fruit Bats are *Boneia*, *Harpyionycteris*, *Cephalotes*, *Callinycteris*, and *Macroglossus*, from the Oriental region, and *Scotonycteris*, *Liponyx*, and *Megaloglossus* from the Ethiopian region; finally, there is the Australian *Melonycteris*.

SUB-ORDER 2. MICROCHIROPTERA.

The members of this sub-order are mostly insectivorous though occasionally "frugivorous or sanguivorous" Bats. The molars are multicuspid with sharp cusps. The palate is not continued back behind the last molar. The second finger has but one phalanx, or

none; occasionally there are two. It has no claw. The ear has its two sides separate from their point of origin upon the head. The group is of Old-World distribution.

Fam. 1. Rhinolophidae.—The Bats of this family possess the leafy outgrowths around the nostrils. The ears are large, but have no tragus. The index finger has no phalanx at all. The premaxillary bones are quite rudimentary, and are suspended from the nasal cartilages. In addition to the pectoral mammae they have two teat-like processes situated abdominally. The tail is long, and extends to the end of the interfemoral membrane.

The genus *Rhinolophus* has a large nose leaf, and an antitragus to the ear. The first toe has two joints, the remaining toes have three joints each. The dentition is I $\frac{1}{2}$ C $\frac{1}{1}$ Pm $\frac{2}{3}$ M $\frac{3}{3}$. There are nearly thirty species of the genus, which are restricted to the Old World. Two species occur in this country, viz. *R. ferrum equinum*, the Great Horse-shoe Bat, and the Lesser Horse-shoe Bat, *R. hipposiderus*. The name is of course derived from the shape of the nose leaf.

The genus *Hipposiderus* and some allied forms are placed away from *Rhinolophus* and its immediate allies in a sub-family Hipposiderinae. The type genus *Hipposiderus*, or, as it ought apparently to be called, *Phyllorhina*, is Old World in range, like all the other members of the family.

The nose leaf is complicated, and there are only two phalanges in all the toes; there is no antitragus to the ear. A curious feature in the osteology of the genus, and indeed of the sub-family, is the fact that the ileo-pectineal process is connected with the ilium by a bony bridge; this arrangement is unique among mammals.

The genus *Anthops*, only known from the Solomon Islands, and represented there by but a single species (*A. ornatus*), has an extraordinarily complicated nose leaf. The tail, like that of the Oriental *Coelops*, likewise represented by a single species (*C. frithii*), is rudimentary.

Triaenops, Ethiopian and Malagasy, has, like the Australian *Rhinonycteris*, a well-developed tail. *Triaenops* has also a highly-complicated nose leaf.

Fam. 2. Nycteridae.—This family is to be distinguished from the Rhinolophidae by the fact that the ear has a small tragus, and by the small and cartilaginous premaxillae. In addition to

these two characters it may be added that the nose leaf is well developed, but is not so complicated as in the last family. The type genus *Nycteris* is Ethiopian and Oriental, nine species being African, and only one, *N. javanica*, being, as the specific name denotes, from the East. *Megaderma* is to be distinguished by the loss of the upper incisors. There is no tail, and the ears are particularly large. They are carnivorous Bats, and *M. lyra*, called the "Indian Vampire Bat," chiefly affects frogs as an article of diet.

Fam. 3. Vespertilionidae.—This family has not the nose leaf of other families. The apertures of the nostrils are simple, round, or crescentic apertures. The ear has a tragus, and the tail is not produced to any great degree behind the interfemoral membrane. There are two phalanges to the index digit.

This family in numbers of species is vastly in excess of any other family of Bats. The most recent estimate, that of P. L. and W. L. Sclater, allows 190. But the generic types are by no means so numerous as in the Phyllostomatidae. This is a significant fact when we reflect upon the geographical range of the two families. The Vespertilionidae range over the whole earth, while the Phyllostomatidae are practically limited to the South American continent, only just getting into the Nearctic region. They inhabit, therefore, a more restricted area, and, in consequence of competition, have specialised more freely than the widely-spread and therefore not crowded Vespertilionidae.

The genus *Vesperugo* is by far the largest genus of this family, embracing no less than seventy species. The tail is shorter than the head and body together; the ears are separate, and moderate or short in size; the tragus is generally short and obtuse. The dentition is I 2, C 1, Pm 2 or 1, M 3. It is a remarkable fact that this genus, unlike most Bats, produces two young at a time. The genus is universal in range, and one species, the Serotine Bat, known in this country, even ranges from the New World to the Old; but with so small a creature the possibility of accidental transportation by man must not be left out of sight. The British species are—*V. serotinus*, the Serotine already mentioned, *V. discolor*, a single example only of which has occurred, and may have been introduced; *V. noctula*, the habits of which were described by Gilbert White; *V. leisleri*; and the Pipistrelle, *V. pipistrellus*, which is the best-known member of the genus in this country.

The genus *Vespertilio* contains some forty-five species, and is world-wide in range. It has one more premolar in the upper jaw than has *Vesperugo*. There are no less than six British species, of which *V. murinus* is the largest species of Bat recorded from this country, but is not quite certainly indigenous.

Plecotus has very long ears. The dentition is I $\frac{2}{3}$ C $\frac{1}{1}$ Pm $\frac{2}{3}$ M $\frac{3}{3}$. The tragus is very large. There are but two or possibly three species, of which one is North American, and the other is the Long-eared Bat, *P. auritus*, of this country, but ranging as far as India. The shrill voice, inaudible to some ears, of this Bat has been heard *of* by everybody.

Synotus includes the British Barbastelle, *S. barbastellus*, as well as an Eastern form. It differs from the last genus principally by the loss of a lower premolar. The ears, too, are not so large. *Otonycteris*, *Nyctophilus*, and *Antrozous* are allied genera; the last is Californian, the others Old-World forms.

Kerivoula (or *Cerivoula*) has a long, pointed, narrow tragus. The tail is as long as or longer than the head and body. The dentition is as in *Vespertilio*; but the upper incisors are parallel instead of divergent as in that genus. The brilliantly-coloured *K. picta* is, on account of this very fact, the best-known species. The name *Kerivoula*, a corruption of the Cinghalese "Kehel vulha," signifies plantain bat. This Bat has been described as looking, when disturbed in the daytime, more like a huge butterfly than a Bat, which is naturally associated with sombre hues. Other species occur in the Oriental, Australian, and Ethiopian regions.

Miniopterus has a premolar less in the upper jaw; it has a long tail as in the last genus. One species, *M. scheibersi*, has almost the widest range of any Bat, it being found from South Europe to Africa, Asia, Madagascar, and Australia.

Natalus is an allied form from Tropical America and the West Indies. It is chiefly to be separated from *Kerivoula* by the short tragus to the ear.

Thyroptera is also South American. It is distinguished by the curious sucker-like discs upon the thumb and foot. These "resemble in miniature the sucking cups of cuttle-fishes." The Madagascar genus, *Myxopoda*, with but one species, has also an adhesive but horse-shoe-shaped pad upon the thumb and foot.

Scotophilus has shortish ears with a tapering tragus. The tail is shorter than the head and body, and is nearly contained within

the interfemoral membrane. The dentition is I $\frac{1}{3}$ C $\frac{1}{1}$ Pm $\frac{1}{2}$ M $\frac{3}{3}$, with another upper incisor in the young. It is African, Asiatic, and Australian.

This genus appears to be connected with *Vesperugo* by Mr. Dobson's proposed genus, or sub-genus as it is generally held to be, *Scotozous*.[1] The genus *Nycticejus*, founded for the inclusion of *Scotozous dormeri*, an Indian species, should, according to Dr. Blanford, replace on grounds of priority the name *Scotophilus*. But as this name (*Nycticejus*) is one introduced by Rafinesque, whose work was so uncertain and untrustworthy, it seems preferable to retain the better-known name of *Scotophilus*, introduced by William Elford Leach.

The genus *Chalinolobus*[2] has short, broad ears with an expanded tragus. A distinct fleshy lobule projects from the lower lip on either side of the mouth. The tail is as long as the head and the body. The dental formula is I $\frac{2}{3}$ C $\frac{1}{1}$ Pm $\frac{2}{2}$ or $\frac{1}{2}$ M $\frac{3}{3}$. The genus occurs in Africa, Australia, and New Zealand; but the African species, with diminished premolars and pale coloration, have been distinguished as *Glauconycteris*.

Fam. 4. Emballonuridae.—The Bats belonging to this family have no nose leaf. The tragus is present, but often very small. The ears in this family are often united. There are two phalanges in the middle finger. The tail is partly free, either perforating the interfemoral membrane and appearing upon its upper surface, or prolonged beyond its end The face is obliquely truncated in front, the nostrils appearing beyond the lower lip.

Emballonura is Australian, Oriental, and Mascarene in range. The ears arise separately, and there is a fairly developed and narrow tragus. The tail perforates the interfemoral membrane. The dental formula is I $\frac{2}{3}$ C $\frac{1}{1}$ Pm $\frac{2}{2}$ M $\frac{3}{3}$.

Rhinopoma has the ears united; the incisors are reduced by one on each side of each jaw, and the premolars are similarly reduced, but only in the upper jaw.

Noctilio is an American genus of two or three species, which has one pair of markedly large upper incisors, which completely conceal the outer pair. On these grounds this Bat was removed from its allies and placed by Linnaeus among the Rodents, an instance of the disadvantage of the artificial scheme of classification. The species named *N. leporinus* has been shown to feed upon fish.

[1] Dobson, *Proc. Zool. Soc.* 1875, p. 370

[2] *Ibid.* p. 381.

Furia, *Amorphochilus*, *Rhynchonycteris*, *Saccopteryx*, *Cormura*, and *Diclidurus* are other Neotropical genera of the same family.

The genus *Taphozous*[1] has a tail which perforates the interfemoral membrane, appearing on its upper surface; it is capable of being withdrawn. The premaxillaries are cartilaginous. The dentition is I $\frac{1}{2}$ C $\frac{1}{1}$ Pm $\frac{2}{2}$ M $\frac{3}{3}$. The upper incisors often disappear. Many species of the genus have a gular sac, opening anteriorly between the jaws. This is better developed in the males. The genus ranges from Africa through Asia to New Guinea and Australia. There are some twelve species.

The genus *Molossus*[2] has short legs and well-developed fibulae. The tail is thick and fleshy, and is prolonged far beyond the margin of the interfemoral membrane. The ears are united together above the nose; the tragus is minute. The dentition is I $\frac{1}{1}$ or $\frac{1}{2}$ C $\frac{1}{1}$ Pm $\frac{1}{2}$ or $\frac{2}{2}$ M $\frac{3}{3}$. This genus, which is confined to the tropical and subtropical portions of America, has long and narrow wings. The Bats can thus fly rapidly, twist about with ease, and capture strongly-flying insects. There are a large number of species.

Nyctinomus is an allied genus, and also has many species. These range through both hemispheres. The chief differences from *Molossus* are that the premaxillary bones are separate in front or united by cartilage, and that the incisors may be three in the lower jaw.

Fam. 5. Phyllostomatidae.—The Bats of this family are extremely numerous and almost entirely confined to South America. None of them occur outside the New World. There are some thirty-five genera. The members of the family are to be distinguished by the presence of the nose leaf, by the well-developed premaxillae, and by the possession of three phalanges by the middle finger. They are large, and the tragus of the ear is well developed.

Vampyrus of South America contains the large species *V. spectrum*, which, mainly on account as it seems of its "forbidding aspect," was supposed to be a bloodsucker. This genus has two incisors on each side of the upper jaw.

The genus *Glossophaga* represents another type of structure in this family. The tongue is long and extensile, and is much attenuated towards the tip, where it is covered with strong and recurved papillae. This structure was at one time thought to indicate a

[1] Dobson, *Proc. Zool. Soc.* 1875, p. 546. [2] *Ibid.* 1876, p. 701.

bloodsucking habit; but its use appears to be merely that of scooping out the soft insides of fruits, upon which the Bat mainly lives. The incisors are only one on each side of the upper jaw. The really bloodsucking Bats of this family belong to the genera *Desmodus* and *Diphylla*. The former is the Vampire, the species being known as *Desmodus rufus*. These Bats have no tail; there is no true molar tooth; the canines are large, and the single pair of upper incisors quite caniniform, and very sharp and strong. These are the main teeth for aggression. In accordance with its diet of blood, the Vampire has a peculiarly modified intestine. The gullet is provided with a bore so small that nothing but fluid food could pass down it; the stomach is intestiniform in shape.

CHAPTER XVII

PRIMATES

Order XIII. PRIMATES.

THE highest of mammals, the Primates,[1] may be thus differentiated from other groups :—Completely hairy, generally arboreal mammals, with five digits on fore- and hind-limbs, provided with flat nails (except in the case of certain Lemurs and the Marmosets), the phalanges that bear these being flattened at the extremity and expanded rather than diminished in size. The fore-feet are grasping hands as a rule, and the hind-feet walking as well as (generally) grasping organs, and the mode of progression is plantigrade. The teats, except in *Chiromys*, are thoracic, and even axillary in position. The skull is characterised by the fact that the orbital and the temporal vacuities are, at least partly, separated by bone. The clavicles are always present. The carpus has separate lunar and scaphoid bones, and the centrale is often present. There is rarely an entepicondylar foramen in the humerus, except in some archaic Lemurs. The femur has no third trochanter. The stomach is usually simple, being sacculated only in Semnopithecinae. The caecum is always present, and often large.

This great group could be easily divided into two separate orders, the Apes and the Lemurs, if it were not for certain fossil types. As will be seen from the description of *Nesopithecus* and of *Tarsius*, the actual hard and fast lines between *all* Apes and *all* Lemurs are very few. On the other hand, it is a little difficult to draw a hard and fast line between the Primates as a whole—or at least between the Lemurine section—and the Creodonta, a

[1] For a general account of the Primates, see Forbes in *Allen's Naturalists' Library*, London, 1894.

group to which so many others appear to converge.' It is disputed, for example, whether the Chriacidae among extinct Lemurs are rightly placed, or whether they should be referred to the Creodonta. The number of primitive characters seen among the Primates, even in Man himself, is remarkable. Of these the more important are the five digits of both limbs and the plantigrade walk, the presence of clavicles and of a centrale, and the absence of a third trochanter. All these features distinguish the early Eutheria.

SUB-ORDER 1. LEMUROIDEA.[1]

The animals known as Lemurs, from their nocturnal and ghostly habits, are on a lower level of organisation than the other division of the Primates. Even the external form enables the members of the present sub-order to be readily distinguished from the higher Anthropoidea The head is more like that of a Fox, with a sharp muzzle; it lacks the human expression of the face of even the lower among the Apes. The long tail is never prehensile, and there is never any trace of cheek pouches or of integumental callosities, which are frequently so characteristic of the Apes. The Lemurs agree with the remainder of the Primates in having pectoral mammae (sometimes abdominal ones are present in addition, and in *Hapalemur*—in the male at least—there is a mamma upon each shoulder), in having opposable thumbs and toes, and in the flattened digits. The tail varies from complete absence (in the *Loris*) to a great length and bushiness in the Aye-aye. The pectoral limbs are always shorter than the hind-limbs; the reverse is occasionally the case in the Anthropoidea. A curious contrast between the two divisions of the Primates concerns the digits of the hands and feet. In the Anthropoidea it is the hallux or pollex which is subject to great variation. In the Lemurs, on the contrary, the thumb and great toe are always well developed, but the second or the third digit constantly shows some abnormality; thus the singular elongation of the third digit of the hand in *Chiromys* and the absence of the index in the *Potto*.[2] In all Lemurs the

[1] See Dr. Mivart's papers in *Proc Zool. Soc.* 1864, -65, -66, -67, and -73 for osteology and teeth.

[2] Murie and Mivart, *Trans. Zool. Soc.* vii. 1869, p. 1

second toe is furnished with a sharp nail, unlike the flattened nails of the other fingers and toes; and in *Tarsius* the third also is thus provided. As to osteology, the shape of the head, already referred to, indicates some of the differences in the skull which mark off the Lemurs from the Anthropoidea. The brain case is small relatively to the face; the orbital and temporal fossae are in communication, though the frontal and jugal bones are united behind the orbit. The two halves of the lower jaw are not invariably ossified to form one piece, as is the case with most Apes. The lachrymal foramen lies upon the face in front of the orbit. The teeth are characteristic, not so much in their number (the dental formula is usually I 2, C 1, Pm 3, M 3 = 36) as in the disposition of the incisors. The incisors of the lower jaw and the canines project forwards in a way only found in a few American Monkeys; as in the Apes there are four incisors in each jaw, but, with the exception of the highly aberrant *Chiromys*, there is a space in the upper jaw between the incisors of the two sides. The canines of the lower jaw, moreover, are often incisiform. There is a well-developed sublingua beneath the tongue (see p. 61). The stomach is perfectly simple; and the caecum, always present and varying in length, never has a vermiform appendix. The gall-bladder is always present. The brain differs from that of the Anthropoidea in that the cerebellum is, as in the lower Mammalia, exposed. The convolutions upon the cerebral hemispheres are not greatly developed, a circumstance, however, which (see p. 77) may have more relation to the size of the animals than to their mental development. Though the brain in its general outlines is not like that of the other Primates, there are certain resemblances; the most striking of these is perhaps the presence, though in rather a rudimentary condition, of the "Simian fissure."

The Lemurine brain has been chiefly studied by Flower,[1] by Milne-Edwards,[2] and by myself.[3] There are also a number of scattered papers dealing with particular types, such as the memoirs of Owen[4] and Oudemans,[5] upon the brain (and the general anatomy) of *Chiromys*. Without going into great

[1] *Trans. Zool. Soc.* v 1863, p. 103.

[2] *Hist. Nat. de Madagascar, Mamm.* 1875.

[3] *Proc. Zool. Soc.* 1895, p 142.

[4] *Trans. Zool. Soc* v. 1863, p. 33.

[5] *Verh. Ak. Amsterdam*, xxvii. 1890, Art 2.

detail it may be stated generally that the anatomy of the brain of this group confirms the classification which is adopted in this work.

A curious feature in the anatomy of the Lemurs, which they share with animals so remote from them in the system as the Edentata, is the breaking up of some of the arteries of the limbs to form retia mirabilia, nothing of the kind is known among the other Primates.

Perhaps the most remarkable difference between the Lemurs and the Anthropoidea, which are really in many respects more closely allied than might be inferred from the above summary of differences, is in the structure of the placenta. The Lemurs agree with the Ungulates in having a non-deciduate placenta.

A curious feature confined to the sub-family Lemurinae was first discovered by myself in *Hapalemur griseus*.[1] On the forearm (see Fig. 258) is an area of hardened skin, which is raised into spine-like processes. Fully developed, this organ is characteristic of the male, the area being marked off in the female, but without the spiny outgrowths. On removing the skin a gland about the size and shape of an almond is brought into view. In other Lemurs there is no modified skin, but a small tuft of particularly long hairs, which are also present in *Hapalemur*, and a small gland beneath the skin. The gland of *Hapalemur* may be comparable with a tract of hardened skin in *Lemur catta*, which projects to a large extent and has been spoken of as a "climbing organ."

An almost exactly similar tuft of spine-like outgrowths exists upon the lower end of the ankle of *Galago garnetti*. The spines are black and bent, just as they are in *Hapalemur*. There appears also to be a gland. This structure is not universal in the genus *Galago* any more than is the patch of spines in the genus *Hapalemur*.

In addition to this gland and to the patch of spines which cover it, the same Lemur as well as *Chirogaleus* and certain species of *Lemur* possess to the inner side of it a bundle of long and stiff bristles associated with unusually large sebaceous glands; these structures are, of course, not homologous with the gland of the arm of *Hapalemur*, as they coexist in the same

[1] "On some Points in the Structure of *Hapalemur griseus*" *Proc. Zool. Soc.* 1884, p. 301.

species. They are, moreover, not peculiar to the Lemurs, but exist in the Squirrel, in the Domestic Cat, in the Leopard, in *Bassaricyon*,[1] the Otter, various Marsupials, and doubtless in

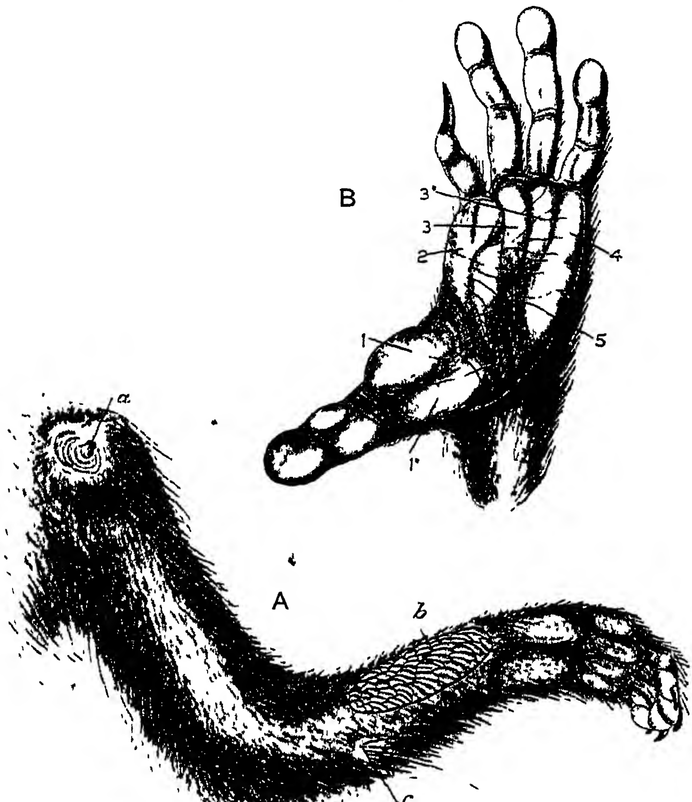


FIG 258.—A, left arm of *Hapalemur griseus* ♂. *a*, Teat, *b*, spines on arm gland, *c*, tactile bristle. B, left foot of *Nycticebus tardigradus*. 1 to 5, Pads upon sole of foot. (After Sutton, and Mivart and Murie.[2])

many mammals which require a tactile organ, for these hairs are associated with a large branch of the radial nerve.

The Lemurs have at the present time a most remarkable distribution. There are altogether about fifty species, referable to seventeen genera Thirty-six species are confined to Madagascar

[1] Beddard, *Proc. Zool. Soc.* 1900, p. 661.
[2] On the Arm Glands of the Lemurs, *Proc. Zool. Soc.* 1887, p. 369.

and to some small neighbouring islands. The rest occur in the Ethiopian and in the Oriental region. The rest of the world is at present totally without Lemurs, though, as will be seen in the sequel, the order was more widely spread over the globe in past times.

Fam. 1. Lemuridae.—This family can be usefully subdivided into four sub-families.

Sub-Fam. 1. Indrisinae.—This sub-family is limited to Madagascar, and has been exhaustively treated of by M. Grandidier and Professor Milne-Edwards in the *Histoire de Madagascar*. These Lemurs contrast with others by the large size of the hind- as compared with the fore-limbs. The ears are short. The tail varies in length. The thumb is but slightly opposable, and the toes are webbed. Correlated with the first two of these characters, these Lemurs when upon the ground progress by means of the hind-limbs, holding their arms above their heads. The number of teeth is reduced, the total being thirty. The formula[1] is I $\frac{2}{2}$ C $\frac{1}{0}$ Pm $\frac{2}{2}$ M $\frac{3}{3}$. The colon or large intestine, as figured by Milne-Edwards, has a remarkable watch-spring-like coil, highly suggestive of the Ruminants and of certain Rodents. This, however, is only in *Propithecus* and *Avahis*. The caecum in this sub-family is specially large. The brain is characterised by the comparatively slight development of the angular fissure in *Propithecus* and *Avahis;* it is in them anterior in position In *Indris* it is more S-shaped and larger as in *Lemur*. The parieto-occipital fissure is fairly well developed, so too is the antero-temporal.

The genus *Indris* has more pronounced external ears than have the two other genera of the sub-family. The tail is rudimentary. The incisors of the upper jaw are sub-equal and set close together, those of the lower jaw have marked longitudinal ridges upon the outer surface, which suggests *Galeopithecus* (see p. 520). The molars are quadricuspidate. There is but a single species, *I. brevicaudata*, which is of a black colour, diversified with white upon the rump and the limbs. The term "Indri"[2] means, as does "Aye-aye," "look." One of the native names for the

[1] So at least the formula has been given; but it is very possible that the supposed second incisor is really, judging from the other Lemurs, a canine

[2] The Malagasy, however, must be vague in definition, or their interpreters not well grounded in the rudiments of the language; for Sonnerat states that Indri signifies "homme des bois."

animal, "Amboanala," signifies "dog of the forest," and is derived not only from the woeful howls of the creature, but from the fact that in certain parts of the island it is used as a dog to chase birds.

These howls are largely effected by means of a laryngeal pouch, which is described as different from that of Apes; the mechanism must also differ from that of *Megaladapis,* inasmuch as the lower jaw is not deep as in that extinct Lemur. The Indri is the largest of Lemurs, measuring about two feet in length. It is arboreal and social, travelling in large companies. As is the case with the *Propithecus,* the natives of Madagascar hold the Indri in awe and veneration. It is curious that the name Lemur or ghost is peculiarly applicable to the Indri or Babakote in another sense from that which led to its adoption by Linnaeus. The natives, in fact, believe that men after death become Indris. Naturally, therefore, these Lemurs have reaped the advantage of this superstition in almost perfect immunity from destruction. Their "long-drawn-out, melancholy cries" are probably at the root of much of the ghostly terrors which they inspire.

The genus *Avahis*[1] has but a single species, *A. laniger*, which is the smallest of this sub-family. It is a foot long without the tail. The Avahi has a long tail (15 inches in length) like *Propithecus.* The outer incisors are larger than the inner, thus differentiating the genus from *Propithecus.* The molars of the upper jaw are quadricuspidate, of the lower jaw five cusped. This genus has only eleven pairs of ribs instead of the twelve of *Indris* and *Propithecus.* The Avahis, unlike the Sifakas and Indrinas, lead a solitary life, or go about in pairs They are, moreover, completely nocturnal

The genus *Propithecus* is characterised by the fur being rather silky than woolly, which latter is the kind of fur found in the two other genera of the sub-family. They are also rather larger animals, the body reaching a length of nearly 2 feet. The tail is long as in *Avahis;* the inner incisors are larger than the outer. The "Sifakas," as these Lemurs are termed, have a reputation for gentleness of character, but, as is the case with other animals, the males fight for the possession of the females at the breeding season. They are mainly vegetarian in habit, and travel in large companies. There are at least three species, and

[1] Syn. *Microrhynchus.*

several varieties are allowed. The colours of these Lemurs are bright, and distributed so as to form contrasting bands; thus *P. coquereli*, a variety of *P. verreauxi*, has a black face and a body mainly white, with splashes of a rich maroon upon the limbs and upon the chest.

These Lemurs are diurnal, and are especially active in the early morning and evening, sleeping, or at any rate remaining quiet, during the heat of the day. Their fitness for an arboreal life is shown by the existence of a parachute-like fold of skin between the arms and the body, which suggests a commencement of the more complete parachute of Flying Foxes, etc. These Lemurs are said to be reverenced and therefore shielded from injury by the natives of Madagascar.

Sub-Fam. 2. Lemurinae.—The "True Lemurs" are all inhabitants of Madagascar and of the Comoro Islands. They have not such long hind-limbs as have the members of the last sub-family, nor are the toes webbed. The tooth formula differs from that of the Indrisinae in that there is one more premolar on each side of the upper jaw, and often one more incisor in the lower jaw, making thus a total of thirty-six teeth. Sometimes, however, the incisors of the upper jaw are totally wanting.

The Hattock, genus *Mixocebus*, is a scarce creature, only known from a single species, *M. caniceps*. As it is rare, nothing is known of its habits. It has one pair of upper incisors. The creature is one foot and half an inch long, exclusive of the tail, which is an inch longer than the body.

Genus *Lepilemur*.—The Lemurs belonging to this genus, entirely confined to Madagascar, as are all the Lemurinae, have received the perfectly unnecessary and pseudo-vernacular name of "Sportive Lemurs"; an equally inappropriate and not at all ingenious name of "Gentle Lemurs" being bestowed upon the allied genus *Hapalemur*. In *Lepilemur* there are seven species, which are to be distinguished from *Mixocebus* in having the tail shorter than the body. There are no incisors in the upper jaw. The last molar is tricuspidate in the upper jaw; that of the lower jaw has five cusps. They are nocturnal creatures, and but little is known of their habits. Previously to Dr. Forsyth Major's visit to Madagascar only two species of the genus were known; he has added five others. The length of the body is 14 inches, and that of the tail 10 inches, in *L. mustelinus*, which is the largest species.

The genus *Hapalemur* [1] has a shorter muzzle than *Lemur*, and shorter ears. There are two pairs of mammae instead of only one; these are upon the breast and abdomen. In the male there is a pair upon the shoulder. The incisors are small, sub-equal, and placed one behind the other; the last one is at the inside of the canines. The molars of the upper jaw and the last premolar have only three well-marked cusps; in the lower jaw they have four. The caecum is blunter and is not so long as in *Lemur;* it differs from that of other Lemurinae in having only two supporting mesenteries, which are both furnished with blood-vessels. As in *Lepilemur* and the Indrisinae the carpus has no os centrale.

The genus, which is confined to the island of Madagascar, has two species, of which one, *H. simus*, is the larger and has a broader muzzle, and does not possess the peculiar arm gland (Fig 258) already described in *H. griseus*. The former species is stated by Mr. Shaw to be chiefly a grass-eater, and to dislike berries and fruits, which are usually so popular with Lemurs. It is, however, believed by some that there is but one species of *Hapalemur*. *H. griseus* is 15 inches long, and has a tail of the same length. Its native name is "Bokombouli." It is nocturnal, and is especially addicted to bamboos, upon the shoots of which it feeds and among which it lives. It is often exhibited in the Zoological Society's Gardens; but the specimens seem to be always males. This Lemur is of a dark iron-grey colour with a tinge of yellow, more marked in individuals which have received the separate specific name of *H. olivaceus*.

The genus *Lemur* is distinguished by the long tail, half as long as the body at the least, by the elongated face, and by the Fox-like muzzle; the teeth are present to the full number of the family, viz. thirty-six; the incisors are small and equal in size, and are separated from each other and from the canines by spaces. The molars of the upper jaw have five cusps, but there are only four in the lower jaw.

This genus is entirely confined to Madagascar and the Comoro Islands, and consists of several species, the exact number of which is doubtful. Wallace in his *Geographical Distribution* allows fifteen, Dr. Forbes only eight, with a plentiful allowance of varieties. One of the best-known species is *Lemur catta*, the

[1] Beddard, *Proc. Zool. Soc.* 1884, p. 391, and 1891, p. 449; and Jentink, *Notes Leyd. Mus.* 1885, p. 33.

Ring-tailed Lemur, or the "Madagascar Cat" of sailors. *Lemur macaco* shows a remarkable sexual dimorphism, the male being black, and the female—formerly described as a distinct species, *L. leucomystax*—being reddish brown with white whiskers and ear tufts. This led to a confusion with a totally distinct species, *L. rufipes*, of which the male (regarded as distinct and called *L. nigerrimus*) is entirely black. This latter identification is, however, considered by Dr. Forsyth Major[1] to be not quite certain at present.

The young Lemur is at least sometimes carried by the mother across her belly; its tail passes round her back and then round its own neck.

The Lemurs of this genus agree with those of some other genera in the loudness of their voice, which is constantly

FIG. 259.—Ruffed Lemur. *Lemur varius*. × ⅕

exercised. Some move about by day and others by night. They are insectivorous and carnivorous as well as vegetarian; and Mr. Lydekker suggests[2] that their abundance and hardiness is to be traced to this fondness for a mixed diet. *Lemur catta* seems to be the only member of the genus that is not arboreal. It lives among rocks where but few trees, and those much stunted, occur. Many species of *Lemur* are always to be seen in the Zoological Society's Gardens. Fourteen "species" have at one time or another been exhibited.

Sub-Fam. 3. Galagininae.—This sub-family is found on the continent of Africa as well as in Madagascar; but the genera are

[1] *Proc. Zool. Soc* 1899, p. 554.
[2] *Royal Natural History*, London, 1894, p. 211.

different in the two districts. In Madagascar we have *Opolemur*, *Microcebus*, and *Chirogale;* on the continent, *Galago*. The members of this sub-family have markedly large ears, which are but little furry; the tail is long. A very marked skeletal character distinguishes this sub-family from other Lemuridae, and allies them to *Tarsius*, that is the lengthening of the calcaneum and naviculare in the ankle. The dental formula is as in *Lemur*. The supporting bands of the caecum are in this sub-family as in the genus *Lemur*. There are but two folds, of which one is median and non-vascular, the lateral fold bears a blood-vessel, and is joined by the median frenum. The brain is but little known. The only figure of the brain of *Galago* is one by myself. There are four mammae, two on the breast and two upon the abdomen.

The genus *Galago* comprises at any rate six distinct species. They are all African, and range right across the continent from Abyssinia as far south as Natal, and to Senegambia in the west. The incisors of the upper jaw are small and equal; there is a gap between the canine and the first premolar. The molars and the last premolar have four cusps; the last molar of the lower jaw has an additional fifth cusp as in *Macacus*, etc. The Galagos are chiefly nocturnal, and are more or less omnivorous Owing to their long hind-legs these animals when they leave the trees advance upon the ground by hops like a Kangaroo. *Galago senegalensis* makes a nest in the fork of two branches, where it sleeps during the day. The Great Galago (*G. crassicaudatus*) is named by the Portuguese "Rat of the Cocoa-nut Palm." Sir John Kirk, after whom a variety of this species is called, relates that it is incapable of resisting the fascinations of palm wine, upon which it will readily intoxicate itself, and as a consequence brave probable captivity. I have referred above (p 536) to the patch of spines upon the tarsus of *G. garnetti*.

The genus *Chirogale* is entirely confined to Madagascar. It is to be distinguished from *Galago* by the fact that the inner incisors are larger than the outer. There are five species of the genus known: four previously to Dr. Forsyth Major's recent visit to Madagascar, and a fifth brought back by him.[1] In connexion with this genus the naturalist just mentioned has observed that all the Lemurs of Madagascar, including the aberrant

[1] See *Novitates Zoologicae*, vol. i. 1894, p. 2.

Chiromys, differ from the African forms by the fact that the tympanic ring "is completely enclosed by the bulla ossea, but without osseous connexion with the same." This character he

FIG. 260.—Smith's Dwarf Lemur. *Microcebus smithii.* × ⅔.

thinks so important as to justify the inclusion of all the Mascarene forms in one group as opposed to another group consisting of the continental Lemurs. In this event *Chirogale*

FIG. 261.—Mouse Lemur. *Chirogale coquereli.* × ½.

will have to be separated from its close association with *Galago*. For the present, however, it is left in the more generally accepted position.

Microcebus contains the most minute among the Lemurs. *M. smithii* has a body only 5 inches long, the tail being another 6 inches. It occurs in Madagascar, and includes five species.

Opolemur, the Fat-tailed Lemur, was so called on account of a

deposit of fat formed chiefly at the root of the tail, and intended to tide over the time of the creature's hibernation. But, as a matter of fact, this peculiarity also exists in *Chirogale*. Of *Opolemur* but two species are known, and of one of these, named after Mr. Thomas of the British Museum, only three examples are in existence in museums, that is to say in one museum—our own at South Kensington. Many of these dwarf Lemurs are exceedingly rare. In this genus and in the last two the palate has a pair of posterior fenestrae, of which there are also traces in other Lemurs, but which are particularly large in *Microcebus*. This is, of course, a well-known character of the Marsupials, and also, which is more important in the present connexion, of certain Insectivores.

Sub-Fam. 4. Lorisinae.—This sub-family is the only one with a wide distribution, and it contains, with the exception of *Tarsius*, the only Asiatic members of the group. Correlated with its wide distribution there is more divergence in anatomical characters than is the case with the other sub-families of the Lemuridae. In external features all the three genera of this sub-family agree in their small size, their short or entirely deficient tail, large staring eyes, and the rudimentary character, or absence, of the index finger, which is never provided with a nail; in all of them the thumb diverges widely from the other fingers, and the great toe is so divergent as to be directed backwards. In the brain there is one character common to all three genera, and that is the small length of the angular fissure. The caecum, which is long, is supported by three folds, of which the median is anangious, and is sometimes attached to the longer of the two lateral folds, which are vascular The members of this sub-family have more dorsal vertebrae than are found in other Lemurs; the range is from fourteen in *Loris*, to sixteen in *Nycticebus*.

The genus *Nycticebus* contains only a single species, *N. tardigradus*, though four other names have been given to supposed varieties. Moreover, the genus itself has been named *Stenops*, as also the next genus *Loris*. The body of this animal is stouter than that of the next to be described. Professor Mivart has pointed out that, though Asiatic like the Loris, it presents more resemblances to the African Potto. The index finger is small; the inner of the two incisors is smaller than the outer, but both of one side are close together. They may be reduced to one on each side of the upper jaw.

The animal has a wide distribution in the East, occurring in Assam and Burmah, the Malay Peninsula, Siam, and Cochin-China, Sumatra, Java, Borneo, and the Philippines. Its vernacular names signify "Bashful Cat" and "Bashful Monkey" in allusion to its nocturnal and shy habits. It lives among trees, which it does not voluntarily leave. Its movements are deliberate, as its popular name, Slow Loris, implies; but it makes up for this by a vigorous tenacity of grasp. The animals "make a curious

FIG. 262.—Slow Loris. *Nycticebus tardigradus.* × ⅓.

chattering when angry, and when pleased at night they utter a short though tuneful whistle of one unvaried note, which is thought by Chinese sailors to presage wind." Much superstition has collected round this harmless though rather weird-looking creature. Its influence over human beings is as active when it is dead as when it is alive. "Thus," writes Mr. Stanley Flower,[1] "a Malay may commit a crime he did not premeditate, and then find that an enemy had buried a particular part of a loris under his threshold, which had, unknown to him, compelled him to act to his own disadvantage." The life of the Loris, adds Mr. Flower,

[1] *Proc. Zool. Soc.* 1900, p. 321.

"is not a happy one, for it is continually seeing ghosts; and that is why it hides its face in its hands!"

The genus *Perodicticus* contains two quite recognisable species, known respectively as the Angwantibo and Bosman's Potto. The former has been regarded as referable to a distinct genus, *Arctocebus*. A curious internal character of the Potto which is visible, or at least can be felt, externally, is the long neural processes of the cervical vertebrae, which project beyond the level of the skin. The index finger is rudimentary and so is the tail, being only just visible (about an inch in length) in the Potto. The colour of both genera is a reddish grey, redder in the Potto. The incisors are equal and minute. Both species are confined in their range to West Africa, and are arboreal like the other members of the sub-family. The Potto seems to share the leisurely mode of progression of its Asiatic relatives, if Bosman, its original describer, is to be trusted. He says: "By the negroes called Potto, but known to us by the name of Sluggard, doubtless from its lazy, sluggish nature; a whole day being little enough for it to advance ten steps forward." The same writer did not at all appreciate his addition to zoological knowledge, for he remarked that the Potto "hath nothing very particular but his odious ugliness." The Angwantibo is rare and but little known. Our knowledge of its anatomy is derived from a paper by Huxley.[1] It is an animal measuring about $10\frac{1}{2}$ inches in total length to the end of the tail, which is only a quarter of an inch long. The hands and feet are smaller than those of *Perodicticus*. The index finger is rudimentary and has but two phalanges, and it has no trace of a nail. In this it agrees with the Potto, but "the spinous processes of the cervical vertebrae do not project in the manner described by van der Hoeven in the Potto, though they can be readily felt through the skin." The dental formula of this genus as of the last is I $\frac{2}{2}$ C $\frac{1}{1}$ Pm $\frac{3}{3}$ M $\frac{3}{3}$. The last lower molar has a fifth cusp, which is wanting in the Potto. The last upper molar is tricuspid. It is bicuspid in the Potto. It seems impossible to avoid agreeing with Professor Huxley that the Angwantibo is entitled to generic separation.

The genus *Loris* also contains but a single species, *L. gracilis*, and is, as its name denotes, an animal of more slender build than the Slow Loris. Its eyes are very large, and the limbs excessively

[1] "On the Angwantibo," *Proc. Zool. Soc.* 1864, p. 314.

slender. The index finger is much as in *Nycticebus*. The colour, too, is not widely different, being of a yellowish grey, but it lacks the dorsal stripe which distinguishes its relative. The incisor teeth are equal and very small. The last upper molar has four cusps instead of the three of *Nycticebus*. This Lemur is confined to Southern India and Ceylon, and has much the same habits as the last. But it is rather more active, and can capture small birds when sleeping upon the trees; its diet, however, is mixed, and is vegetarian as well as animal.

A mysterious Lemur, which we conveniently place as a kind of appendix to the present family on account of its locality, has been shortly described by Nachtrieb from the Philippines. The tail is rudimentary; there are two upper incisors, but as many as six lower. It is doubtful what the beast really is.

Fam. 2. Chiromyidae.—This family contains but a single genus and species, the Aye-aye, *Chiromys madagascariensis*,

Fig. 263.—Aye-aye. *Chiromys madagascariensis*. $\times \frac{1}{10}$.

whose characters therefore are for the present those of the family as well as of the genus and species. The external features of this extraordinary animal will be gathered from an inspection of Fig. 263, from which it will be seen that the earlier name of *Sciurus* given to the creature was not by any means a misnomer. The Squirrel-like appearance is due, of course, chiefly to the strong and long incisor teeth. As to the external characters, which are of systematic importance,

attention may be called to the long and bushy tail, to the greater length of the hind-limbs, to the abdominal teats (one pair) in the female, and above all to the singular third digit of the hand, which is thin and elongated. The thumb is, as in other Lemurs, opposable, and has a flat nail; the remaining digits have claws, as have also the toes with the exception of the great toe, which has a flat nail like the thumb.

The anatomy of this animal has occupied the attention of a considerable number of observers, dating from Sir R. Owen, who was the first to give a connected account of its entire organisation. The most recent paper of importance is by Dr. Oudemans.[1] The teeth are very unlike those of other Lemurs. The most remarkable divergence is in the incisors, which are present to the number of but a single pair in each jaw, and are shaped like those of the Rodentia, and in the same way as in that group grow from persistent pulps. There are likewise, as in the Rodents, no canines. There are two premolars in the upper jaw (none in the lower) and altogether twelve molars, so that there is a total of eighteen teeth. The intestine has a moderately long caecum. The brain has been most fully described by Oudemans, who had fresh material to work with, the brain described by Owen having been extracted from a spirit-preserved carcase. The angular fissure is well developed, as in *Lemur* and the Indri; but it does not join the infero-frontal. The antero-temporal fissure is also well developed.

"The name of Aye-aye," wrote Sonnerat, the discoverer of the animal, "which I have retained for it, is a cry of surprise of the inhabitants of Madagascar." It is, however, usually said that the animal itself makes a sound which may be written in the same way (or with an initial H). It is an arboreal and nocturnal animal, which accounts for its excessive rarity at one time. In one of his many eloquent essays upon natural history the late Mr. P. H. Gosse adduced the Aye-aye as an example of a creature on the verge of extinction. It is, however, now more frequently met with, though the superstition of the natives renders its capture a matter of some difficulty. There is a specimen at the moment of writing in the Zoological Society's Gardens. There has been some discussion as to the use of the slender middle finger: it is stated that it can thrust it into the

[1] *Verh. Ak. Amsterdam*, xxvii. 1890.

borings of the larva of a certain beetle of which the Lemur is particularly fond, and can extract the insect, or at any rate discover its position, when it may be extracted by the powerful chisel-shaped teeth. The partiality of the Aye-aye for animal food of any kind including insects has been both reaffirmed and denied; and Mr. Bartlett has seen the creature use its slender finger for combing out its hair, and for other purposes of the "toilet." Dr. Oudemans has figured in his paper an apple which has been largely eaten by the *Chiromys;* the fleshy pulp has been entirely excavated, leaving only the core and the skin, which are untouched. The Rev. Mr. Baron is one of the latest writers upon the ways of life of *Chiromys.*[1] He states that it inhabits the most dense parts of the forests. It has the habit of prowling about in pairs, and the female produces but a single young one at a birth. A nest, which is about 2 feet across, is made of twigs in lofty branches. This is occupied during the day, and entered by a hole in the side. With regard to the superstitious veneration in which the animal is held, it is said that if a person sleeps in the forest the Aye-aye will bring him a pillow. "If a pillow for the head, the person will become rich; if for the feet, he will shortly succumb to the creature's fatal power, or at least will become bewitched" But a counter-charm may be obtained. It is said that the reverence for this beast leads the natives to bury carefully a specimen found dead.

Fam. 3. Tarsiidae.—This family also consists of but a single genus, *Tarsius,* to which it is the general opinion that but a single species belongs; there are, however, at least four different specific names on record. The general aspect of the animal is not unlike that of a Galago, with which it also agrees in the elongation of the ankle; but the elongation is more pronounced in the present genus. The ears are large, and the eyes are extraordinarily developed. The fingers and toes terminate in large expanded discs, and are furnished with flattened nails except on the second and third toes, which have claws. The tail is longer than the body and is tufted at the end. The skull is more like that of the Anthropoidea than is the skull of any other Lemur. The resemblance is by reason of the almost complete separation of the orbit and the temporal fossa by bone;

[1] *Proc. Zool. Soc.* 1882, p. 639; see also Rev. G. A. Shaw, *Proc Zool. Soc.* 1883, p. 44, 2nd Art.

there is, however, a gap left to mark the Lemurine characters of the animal. The placenta, too, has been compared to that of the Apes. The dental formula is that of the genus *Lemur*, save for the absence of an incisor on each side of the lower jaw; the number of teeth is therefore thirty-four. The incisors of the lower jaw are upright, and not procumbent as in other Lemurs. The caecum is of moderate length. The brain is almost smooth, but there is a Sylvian fissure and an antero-temporal, which latter does not reach the lower margin of the brain, but divides the middle part of the temporal lobe. The name Tarsier, as may be inferred, was originally given to this creature by Buffon on account of the abnormal ankle, and it was compared by him with the Jerboa, like which animal the Tarsier leaps when it descends to the ground. The genus is Malayan, but its range extends to the Philippines and to Celebes and Borneo. The Tarsiers are nocturnal and particularly arboreal; they live in pairs, in holes in tree stems, and are mainly insectivorous in their food. One, rarely two young are produced at a birth. Contrary to what is found in many Lemurs, the Tarsier is a silent creature, and at most emits a "sharp, shrill call." Dr. Charles Hose, who has studied this creature, has noticed that the mother often carries her young one about in her mouth like a Cat. Like so many Lemurs this animal is held in superstitious dread, which no doubt is the result of its most weird appearance.[1]

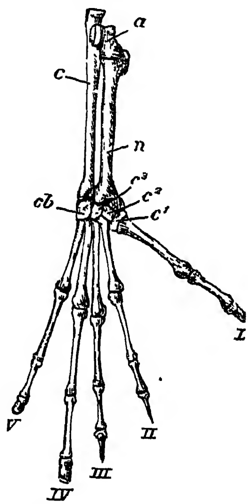


FIG. 264.—Right pes of *Tarsius spectrum*. (Nat. size.) *a*, Astragalus; *c*, calcaneum; c^1, internal cuneiform; c^2, middle cuneiform; c^3, external cuneiform; *cb*, cuboid; *n*, navicular; *I*-*V*, the digits (From Flower's *Osteology*)

Fossil Lemurs.—The Lemuroids are a very ancient race; they extend back to the very earliest strata of the Eocene, the Torrejon and Puerco beds, which, as already said, are thought to be more referable to the Cretaceous than to the Tertiary epoch.

[1] For a survey of the position of *Tarsius*, see Earle, *Amer. Naturalist*, xxxi. 1897, p. 569; and *Nat. Science*, x. 1897, p. 309.

One of these early forms is referred to the genus *Mixodectes*, a genus which has been placed, though with a query, in the order Rodentia. It appears, however, to be a Lemuroid, and is of American range. The incisor teeth have been held to argue that it lies on the direct track of *Chiromys;* but other features, more especially the form of the astragalus, have been used to argue the justice of the inclusion of this type within the order Rodentia. Allied, as it is supposed, to this form is *Indrodon*, also of the lowest Eocene deposits of the United States. *Indrodon malaris* is known from fragments of nearly all parts of the skeleton. They indicate the existence of a creature of about one-half the size of *Lemur varius.* It had slender limbs and a long and powerful tail. The humerus, as in so many archaic beasts, has an entepicondylar foramen. The femur has three trochanters, and the fibula articulates with the astragalus. It is not always easy to distinguish these primitive mammals from each other, so that the minutest of characters have to be called in to our assistance. One of the contemporaneous groups with which these early Lemurs might be confused is that of the Condylarthra; it is important, therefore, to note that in *Indrodon* the calcaneo-cuboidal articulation is nearly flat, and not bent as it is in the former group. The teeth are of the tritubercular pattern. The incisors are not known, but the molars and premolars are each three. To the same family, which has been termed **Anaptomorphidae,** is referred the genus *Anaptomorphus*, which has been specially compared to *Tarsius.* This small animal has a Lemurine face with huge orbits. It has a premolar less than *Indrodon.* It has been ascertained that *A. homunculus* had an external lachrymal foramen.[1]

Another family, that of the **Chriacidae,** appear to hover on the border line of Lemurs and Creodonts, having been referred to both by various palaeontologists. Professor Scott suggests their Lemurine or at least Primate relationships, while Cope urged their Creodont affinities. A difficulty raised by Scott was, that in *Chriacus* the premolars of the lower jaw were spaced. But it appears that this is not fatal to their inclusion in the Primates, since *Tomitherium*, an "undoubted Primate," shows the same feature. If *Chriacus* is a Lemur it is an earlier type than those

[1] See Schlosser, *Beitrage Pal. Osterr. Hung.* 1888; also Osborn and Earle, *Bull. Amer. Mus. Nat. Hist.* vii. 1895, p. 16.

which have been considered; for it has the typical Eutherian dentition of four premolars and three molars. These teeth, especially the superior molars, are particularly compared to the corresponding teeth of *Lemur* and *Galago*. Of this and the allied genus, *Protochriacus*, several species are known.

Adapis, a representative of another family, is one of the best known of ancient Lemuroids. It has the typical mammalian dentition of forty-four teeth in a close series without diastemata. The orbits are completely separated from the temporal cavity, the eyes looking forwards. The canines are large and caniniform. The skull is deeply ridged behind with the usual sagittal crest. This genus is European, and corresponds to the already mentioned American Eocene *Tomitherium*, perhaps belonging to the same family.

Nesopithecus is an extinct genus from Madagascar, lately described by Dr. Forsyth Major.[1] There are two species, *N. roberti* and *N. australis* The dental formula is I 2, C 1, Pm 3, M 3, for the upper jaw, the lower jaw having but a single pair of incisors. The lachrymal foramen is just inside, or on the edge, of the orbit, so that one distinctive Lemurine character is lost. The genus is also Ape-like in the form of the canines and incisors, these having been especially compared by Dr. Forsyth Major with those of the Cercopithecidae. The molars, too, agree with those of the same family. There is, however, one important feature in which *Nesopithecus* resembles not only the Lemurs as opposed to the Apes, but the Malagasy Lemurs. As already mentioned (p. 544), Dr. Major has shown that in the Malagasy Lemurs, even including the aberrant *Chiromys*, and in the Tertiary and European *Adapis*, the bulla tympani is not produced by an ossified extension of the annulus tympanicus, but from the adjacent periotic bone, the annulus remaining separate and lying within the fully-formed bulla. This feature shows conclusively that *Adapis* is a Lemur, and that *Nesopithecus*, originally supposed to be a Monkey, cannot be removed from the Lemuroidea, many though its likenesses to the higher Primates undoubtedly are. However, this feature, combined with the fact that the orbital and temporal cavities are in communication, shows the Lemuroid position of *Nesopithecus*, though it is quite conceivable that it is on the way to become an Ape.

[1] *Proc. Zool. Soc* 1899, p. 987.

A family, **Megaladapididae**, has been quite lately founded by Dr. Forsyth Major [1] to include the remains of a gigantic extinct Lemur from Madagascar, which when alive, so far as we can judge from the skull, must have been three or four times the size of the Common Cat. The name *Megaladapis madagascariensis* was given to the fossil on account of certain resemblances to the also extinct *Adapis*. It differs from other Lemurs in a number of characters which jointly warrant its inclusion in a distinct family. The small size of the orbits suggest a diurnal life; the deep mandibles, which, unlike what is found in other Lemurs, are completely blended at the suture, point to the existence of a howling apparatus, as in *Mycetes*. The low brain-case is a character which is found in so many extinct Mammalia belonging to many different orders that it weighs neither one way nor the other in considering the systematic position of the animal. The shape of the molars, which are three in each half of each jaw as in other Lemurs, is, according to the discoverer, like that of the genus *Lepilemur*. The incisors and the canines are not known Of a still larger form, *M. insignis*, the molar teeth are known.[2]

Sub-Order 2. ANTHROPOIDEA

The Apes differ from the Lemurs in that the teats are always restricted to the thoracic region; the orbit, though surrounded by bone as in the Lemurs (and in *Tupaia*, a very Lemur-like Insectivore), does not open freely behind into the temporal fossa as in Lemurs (except *Tarsius*). The lachrymal opening is inside the orbit instead of outside, the cerebral hemispheres are more highly developed, and conceal, or nearly conceal, the cerebellum; the upper incisors are in close contact; a few other points are mentioned under the description of the characters of the Lemurs. There are altogether about 212 species of Monkeys and Apes. They are tropical and subtropical in range, and, with but few exceptions, are impatient of cold.

The Monkeys are primarily divisible into two great divisions, which have been termed, on account of the characters of the nose,

[1] *Phil. Trans.* clxxxv. B, 1894, p. 15.

[2] It seems to be possible that this great Lemur was extant so lately as 1658, when a creature possibly answering to it was described by de Flacourt.

the Catarrhines and Platyrrhines. In the former the nostrils look downward and are close together; in the latter they are separated by a broad cartilaginous septum, and the apertures are directed outwards. But numerous other points of difference separate these two groups of the Monkey tribe. The Catarrhines often have those remarkable ischial callosities, patches of hard skin brightly coloured; the tail may be totally wanting as a distinct organ, as is the case, for instance, with the Anthropoid Apes; there are often cheek pouches, so that, as Mr. Lydekker has remarked, if a Monkey be observed to stow nuts away in its cheeks for future reference, we may be certain that its home is in the Old World, for the Catarrhines are exclusively denizens of the Old World, while the Platyrrhines are as exclusively New World in range. Again, those of the Catarrhines which do possess a long tail, such as the members of the genus *Cercocebus,* never show the least sign of prehensility in that tail. The teeth of the Catarrhines are invariably thirty-two in number, the formula being $I\,\frac{2}{2}\;C\,\frac{1}{1}\;Pm\,\frac{2}{2}\;M\,\frac{3}{3} = 32$.

In the Old-World Apes there is a bony external auditory meatus, which is wanting (as a bony structure) in the Platyrrhines. The late Mr. W. A. Forbes pointed out that in most of the New-World forms the parietals and the malars come into contact; in the Monkeys of the Old World they are hindered from coming into contact by the frontals and the alisphenoids. The Platyrrhines may have the same number of teeth; this is the case with the Marmosets, but in them there are three premolars and two molars; in the remaining New-World Monkeys there are thirty-six teeth, but of these three are premolars and three molars.

Not only are these two groups of the Primates absolutely distinct at the present day, but they have been, so far as we know, for a very long time, since no fossil remains of Monkeys at all intermediate have been so far discovered. This has led to the suggestion that the Monkeys are what is termed diphyletic, *i.e.* that they have originated from two separate stocks of ancestors. It is hard, however, to understand on this view the very great similarities which underlie the divergences that have just been mentioned. But, on the other hand, it is equally hard to understand how it is that, having been separated from each other for so long a period, they have not diverged further in

structure than they have. The Platyrrhines seem to stand at the base of the series. This is another example of the existence of archaic creatures in South America.

Group I. *PLATYRRHINA.*

Fam. 1. Hapalidae.—We may begin the account of the Platyrrhine Monkeys with the Hapalidae or Marmosets; for this family is structurally lower than the rest. They have thirty-two teeth, arranged as in the following formula: $I\frac{2}{2}\ C\frac{1}{1}\ Pm\frac{3}{3}\ M\frac{2}{2} = 32$. The molars have three main tubercles, and not four as in the higher forms. The digits are for the most part clawed, not nailed, as in the higher types; the great toe alone bears a flat nail. The tail, too, is ringed, a condition which is characteristic of many of the lower groups of mammals, but not of the higher Apes. The cerebral hemispheres are smooth, but this is a matter rather connected with their small size than with low zoological position. The tails of the Marmosets, unlike those of so many other American Monkeys, are not prehensile though they are long.

The genus *Hapale* is broadly distinguished from the other genus, *Midas*, by the fact that the lower incisors slant forwards as in the Lemurs. They are small, soft-furred, long-tailed Monkeys, familiar to every one. There are some seven species, which are entirely restricted in range to Brazil, Bolivia, and Colombia, one species only, *H. pygmaea*, extending northward into Mexico.

Of Tamarins, genus *Midas*, there are rather more species—about fourteen. They are South and Central American in distribution. Since both these genera are arboreal in habit, it is extraordinary that they have not the prehensile tails of their American allies. As, however, the late Mr. Bates observed an individual of the species *M. nigricollis* fall head-foremost from a height of at least 50 feet, alight on its feet, and run off as if nothing in particular had occurred, it is evident that no extra prehensile powers are absolutely necessary. Some of the Tamarins have a long mane; this is well seen in *M. rosalia*, or rather in *M. leoninus*, which, if not identical with it, is at least very closely allied to it. The name is obviously derived from the character

referred to, and the Monkey, originally described by the traveller von Humboldt, is said to have "the appearance of a diminutive lion" *M. bicolor* is an example of the species with no mane, but with a patch of white round the mouth, looking like "a ball of snow-white cotton" held in the teeth.

Fam. 2. Cebidae—The remaining American Monkeys are comprised in the family Cebidae. This is to be distinguished from the last by the fact that there is an additional molar, thus making thirty-six teeth in all. The tail, sometimes very short, is more generally long and highly prehensile, being nude at the extremity, which part is therefore especially prehensile; this state of affairs is often to be seen in animals with prehensile tails. The Cebidae, though for the most part larger than the Marmosets, never approach in size the Old-World Apes.

Typical of the family is the genus *Cebus*, including the "Capuchin" Monkeys, and consisting of nearly twenty species; the tail, though prehensile, is covered with hair to the tip, a fact which is indicative of a less perfect prehensility than is exhibited in some Monkeys with a naked under surface to the tip of the tail. The thumb is well developed. The genus ranges from Costa Rica to Paraguay. The commonest Monkey which accompanies the street organs of this country is a *Cebus*. It is a popular delusion that these and other monkeys are purely vegetable-feeding animals. *Cebus* is in fact particularly fond of caterpillars, as are also the Marmosets.

Allied to *Cebus* is *Lagothrix*, the Woolly Monkey, of which *L. humboldti* is the best-known species, there being indeed but one other. It is a larger and heavier animal than any species of *Cebus;* and the Hare-like woolliness of the fur suggested its scientific name to its original describer, von Humboldt. It has a perfectly prehensile tail, naked at the tip. The thumb and great toe are well developed. These are purely fruit-eating Monkeys, and are known as "Barrigudos" by the Portuguese of the Amazon country on account of their prominent belly, due apparently to the immense amount of fruit consumed. They are, or were, much eaten by natives.

Brachyteles is a little-known genus, connecting the last with the next genus. The under fur is woolly; the thumb is small or absent. The tail is naked below.

The Spider monkeys, *Ateles* or Coaitas, have been described as

the most typically arboreal of American monkeys. The use of the prehensile tail can frequently be studied in living examples in the Zoological Society's Gardens. With this "fifth hand" the Monkey feels for a place to grasp, and securely twists its tail round, moving it with the greatest ease from point to point. When the tail is being thus used it is carried erect over the head. The fact that this genus possesses no functional thumb is thought

FIG 265.—Spider Monkey. *Ateles ater.* $\times \frac{1}{12}$.

to be associated with the extreme perfection of its adaptability to an exclusively arboreal life. The hand without a thumb can act as an equally efficient hook for suspending the body; and what is useless in nature tends to disappear. These Monkeys have a wide range, extending from Mexico in the north to Uruguay in the south. There are ten species. The flesh of many Monkeys is eaten not only by natives but by Europeans; but the Spider Monkeys are said to furnish the most sapid food of all.

The Howling Monkeys, genus *Mycetes,* have also received the appropriate generic names of *Alouatta* and *Stentor.* The former of these two names, indeed, is that which should properly be applied to the genus. But *Mycetes* is perhaps better known. The "howling" is produced by saccular diverticula of the larynx, larger than those of other American Monkeys, such as *Ateles,* where, however, they are also developed. The hyoid bones, too,

are enormously enlarged and cavernous, while the jaw—in order to accommodate and protect these various structures—is unusually large and deep. The Howlers are furnished with a fully prehensile tail. The thumb is present. They are described as being the most hideous in aspect of the American Monkeys, and of the lowest intelligence, with which latter characteristic is associated a less convoluted brain than in *Ateles*, for example. The noise produced by these Monkeys is audible for miles, and is said not to be due to emulation, *i.e.* not to be comparable to singing or talking, but to serve to intimidate their enemies. The story told of these and other Monkeys with prehensile tails, that they cross rivers by means of a bridge of intertwined Monkeys, is apparently devoid of truth. There are six species, which are Central and South American in range.

The Squirrel Monkeys, genus *Chrysothrix*, are small creatures with a long head, the occiput projecting. Their tail, though long, has no naked area at the extremity and is non-prehensile. It is a remarkable fact that the proportions of the cranium as compared with the face are greater, not only than in other Monkeys, but than in Man himself. The thumb is short, but not so short as in the Spider Monkeys. The cerebral hemispheres are very smooth; but, as already remarked, this is a matter of size, and not of low position in the series. It may appear at first sight that this statement contradicts the one made concerning the Howlers. But the latter are large Monkeys, and therefore ought, so to speak, to have a more complex brain; but they have not. Like so many of the American Monkeys, the Squirrel Monkeys are gregarious, and, in spite of their tails, arboreal. They are largely insect-feeders, and also catch small birds and devour eggs. There are four species, of which *C. sciurea* is the commonest, and is constantly an inmate of the Zoological Society's Gardens. Humboldt asserted of it that when vexed its eyes filled with tears; but Darwin did not succeed in seeing this very human expression of an emotion.

Callithrix is a genus not far removed from the last, and, like it, occurs both in Central and in South America. It is chiefly to be distinguished from *Chrysothrix* by the non-extension backwards of the head, and by the more furry character of the tail. The lower jaw is rather deep, as in the Howlers; but there is not, or there has not been discovered, a howling apparatus like

that of *Mycetes*. Nevertheless Professor Weldon[1] has found in a female of *C. gigot* a patch of ossification on the thyroid cartilage of the larynx which may be an indication of something more in the male. There are eleven species.

Nyctipithecus, the Doroucouli Monkeys, is a genus of somewhat Lemurine appearance, caused by their large eyes. But they reminded Bates of an Owl or a Tiger-cat! They have a long, but not prehensile tail. As in the Marmosets, the lower incisors project forwards in a Lemurine fashion. The thumb is very short. A peculiarity of this genus is the twenty-two dorso-lumbar vertebrae. As in *Chrysothrix*, but not as in *Callithrix*, the hemispheres of the brain are smooth. There are five species, of which one occurs so far north as Nicaragua; the rest are Brazilian, extending down to the Argentine.

The Ouakari Monkeys, *Brachyurus*,[2] are, as the name denotes, short-tailed forms. Two species, *B. rubicundus* and *B. calvus*,

FIG. 266.—Red-faced Ouakari. *Brachyurus rubicundus*. × ⅛.

have bright red faces; *B. melanocephalus* has a black one. There is a small thumb. The brain is fairly convoluted, and is to be specially compared with that of *Cebus* and *Pithecia*. The

[1] "Notes on *Callithrix gigot*," *Proc. Zool. Soc.* 1884, p. 6.

[2] Forbes, *Proc. Zool. Soc.* 1880, p. 639.

species *B. rubicundus* at any rate has an absolutely as well as a relatively greater length of intestines and caecum than any other American Monkey known.

Not the least remarkable fact about these Ouakari Monkeys is their distribution in South America. We cannot do better than

FIG. 267.—White-nosed Saki. *Pithecia albinasa.* × ⅙. (From *Nature.*)

quote the summary given by Messrs. P. L. and W. L. Sclater in their *Geography of Mammals,* which is as follows: "Each of them, as first shown by Bates and afterwards further explained by Forbes, is limited to a comparatively small tract of forest on the banks of the Amazon and its affluents. The Black-headed Ouakari (*B. melanocephalus*) . . . is met with only in a tract

traversed by the Rio Negro; the Bald-headed Ouakari appears to be confined to the triangle formed by the union of the Amazon with another affluent, the Japura, and the Red Ouakari to the forests on the north bank of the Amazon opposite Olivença, and lying between the main stream and the River Iça. Each of them evidently takes the place of the others in its particular district. Of this peculiar kind of distribution few instances are known amongst mammals, but many somewhat similar cases have been observed in birds, reptiles, and insects."

The genus *Pithecia*, the Sakis, consists of five species with long bushy tails, which are non-prehensile. They are bearded and have a thumb. Like the last genus, *Pithecia* does not extend into Central America. The incisors project forwards, and the lower jaw is deep, though the howling apparatus of *Mycetes* is wanting. The thin, closely-set, and projecting incisors are very suggestive of those of the Lemurs. *Brachyurus* is much like *Pithecia* in this respect, and both differ markedly from such a genus as *Cebus*, where the lower incisors are vertical. An anatomical peculiarity of *Pithecia* is the breadth of the ribs. *P. satanas* is perhaps the best-known species, but all five have been exhibited at the Zoological Society's Gardens. As its name suggests, *P. satanas* is entirely black; it shows a curious point of difference from *P. cheiropotes* in its way of drinking. The latter species, as its name denotes, uses its hand to drink, while *P. satanas* puts its mouth to the water. *P. albinasa* is black with a red patch on the nose, within which again is a small white patch.

Group II. *CATARRHINA.*

The Catarrhine Apes are divisible into three or perhaps only two families, the Cercopithecidae and the Simiidae, to which must be added the Hominidae. The Simiidae are sometimes spoken of as the Anthropoid Apes.

Fam. 1. Cercopithecidae.—Of the Cercopithecidae there are eight genera (perhaps nine) to be recognised, which may be distributed into two sub-families. The first of these two sub-families, that of the **Cercopithecinae**, has the following characters.—There are cheek pouches in which the animals store food temporarily.

The stomach is simple and globular; this corresponds with a mixed diet. The tail is long or short, or practically absent.

The most familiar genus is undoubtedly *Macacus*. This includes all the common so-called Macaques, the Bonnet Monkey,

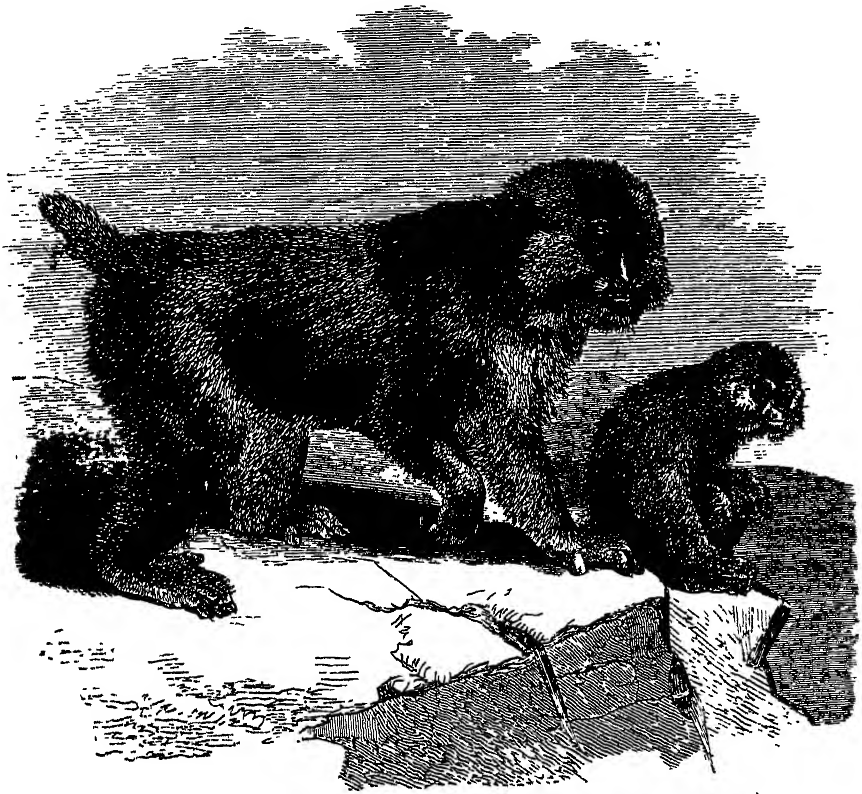


FIG. 268.—Tcheli Monkey. *Macacus tcheliensis*. $\times \frac{1}{8}$ (From *Nature*.)

the Pig-tailed Monkey, etc. In this genus we find that the males are larger than the females, and have stronger canine teeth. Ischial callosities are well developed. The genus is purely Asiatic, reaching as far east as Japan, with the exception of the Barbary Ape, *M. inuus*, also known as the Gibraltar Ape. There are altogether some seventeen species.

Macacus inuus is doubtfully indigenous to Gibraltar. It is, however, definitely established there at present, and is carefully fostered. It is a large Ape with no external tail, in which

particular it is unique among the members of its genus. At one time its extinction on the "Rock" was nearly accomplished, but three individuals being known. In 1893 the Governor of Gibraltar informed Mr. Sclater that he had himself counted as many as thirty in one herd. Its depredations seem to have led to the expression of a wish in some quarters that the numbers should be thinned; but feeling on the opposite side appears to be stronger, so that whatever was the actual mode of its introduction on to the "Rock" it will at any rate remain there unmolested for the present.

M. tcheliensis is a species found in the Yung-ling Mountains in North China. It is, with the possible exception of *M. speciosus*, the most northerly form of Monkey. It is interesting on account of the fact that like the Tiger of those regions it has put on an extra coating of fur to enable it to combat with the bitter winters. It is doubtful whether it is more than a variety of the Rhesus Monkey (*M. rhesus*).

M. nemestrinus, "the Pig-tailed Macaque," is trained by the natives of the east to climb cocoa-nut palms and to carefully select and throw down only the ripe fruit. Sir Stamford Raffles apparently was the first to report upon this useful intelligence of the animal, and Dr. Charles Hose of Borneo has confirmed him.

The Japanese Macaque (*M. speciosus*) is well known from the work of Japanese artists. It is the only species of Monkey found in Japan, and goes very far north.

A rather rare form is *M. leoninus*. It has a short tail, and occurs in Burmah. *M. silenus* is distinguished by a ruff of long light-coloured hair surrounding the face. It is sometimes called the Wanderoo; but this is apparently quite inaccurate, since that term is used by the Ceylonese for a *Semnopithecus*. For those who wish a "pseudo-vernacular" name Dr. Blanford suggests Pennant's name of "Lion-tailed Monkey."

The commonest species of the genus are *M. cynomolgus*, *M. sinicus*, and *M. rhesus*.

The genus *Cercocebus*, including those Monkeys known as Mangabeys, is confined to West Africa. They have always a long tail, quite as long as the body. The upper eyelids are pure white in colour. The ischial callosities are more pronounced than in the Macaques. In the Mangabeys also the hairs are not ringed with differently coloured bars, as is the case with both

Macaques and *Cercopithecus*, giving to them the greenish hue which characterises so many of the last two genera. There are no laryngeal air sacs as in the Macaques. There are not more than seven species.

The genus *Cercopithecus* (the Guenons) represents in Africa the Oriental and Palaearctic Macaques; the genus has a long tail. The cheek pouches are larger than in the genus *Macacus*. The ischial callosities are less extensive than in that genus. A tooth character also distinguishes this genus from *Macacus;* the last molar of the lower jaw has, as a very general rule, only four cusps instead of the five which are found in *Macacus*. The supraciliary ridges in the skull are by no means so marked as in the allied genera.

One species, the Talapoin, *C. talapoin*, has been separated into a distinct genus, *Miopithecus*, on account of the fact that the lower molars have only three tubercles instead of the usual four. But if this be done, then *Cercopithecus moloneyi*, which has a lower molar with five tubercles, should also be separated.

The genus *Cercopithecus* is limited to Africa, and its numerous

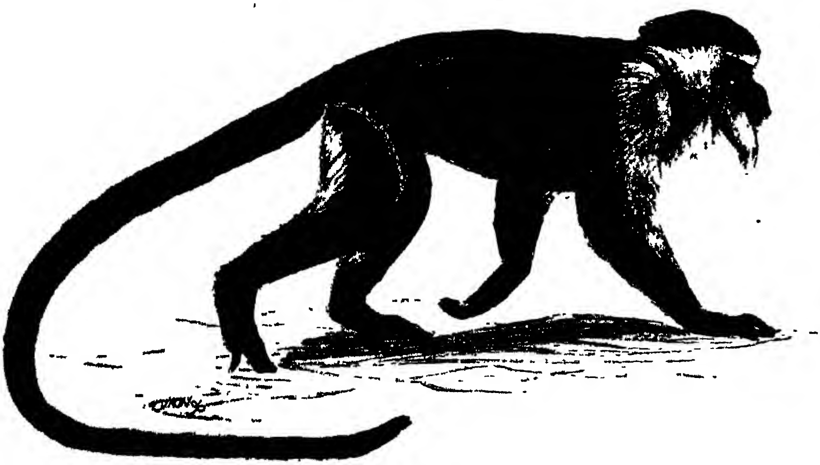


FIG. 269.—Diana Monkey. *Cercopithecus diana*. × ⅛.

species have often a very limited range. They are frequently rather brightly coloured, with blue and white patches on the face. The Diana Monkey has a pointed white beard. Of the Vervet Monkey (*C. lalandii*) a curious fact was noticed at the Zoological

Society's Gardens a year or two back: the young was observed to take both teats of the mother into its mouth at once. Mr. Sclater[1] in a recent list of the group allows forty-seven species, of which thirty-three were examined by himself. Subsequently, however, the list has been reduced to forty by the same authority. One of the rarest species is *C. stairsi*, first described from a skin stripped from a specimen which lived for a short time at the Zoological Gardens.

The genus *Cynocephalus* (or *Papio*) includes the Baboons, and the scientific name indicates the Dog-like aspect of these animals, due to the projecting snout. *Cynocephalus* is confined to Africa and Arabia. Several of the species of the genus are well known. The Mandrill, *C. mormon* (or *maimon*), has blue ridges on the muzzle, the bridge of the nose being red. The animal lives in herds, and is ferocious and omnivorous. The Chacma Baboon, *C. porcarius*, is the largest of Baboons. It lives in South Africa in large herds. The Arabian Baboon, *C. hamadryas*, is the Sacred Baboon of the Egyptians. The names of two other species, *C. thoth* and *C. anubis*, serve also to remind us of the ancient Egyptians. There are altogether eleven species of *Cynocephalus*.

Gelada (or *Theropithecus*) is separated as a distinct genus. Though regarded as a Baboon, Garrod has pointed out many points of likeness to *Cercopithecus*.[2] The two species are, like the other Baboons, African.

Cynopithecus niger is a small black Baboon from Celebes. It has swellings on the muzzle as in other Baboons, but differs from them in being a more amiable creature as well as in its smaller size. It has a rudimentary tail, smaller even than the small tail of the typical Baboons. It has, like them, ischial callosities.

In the second sub-family, **Semnopithecinae,** the following characters are distinctive.—All the Apes of this group are slender in form, with a long tail. There are no cheek pouches. The stomach is sacculated; it is divided into three portions. This is accompanied by an apparently more exclusively vegetarian diet than characterises other Apes, which mingle with their diet of fruit a large proportion of insects, eggs, etc.

1 "On a new African Monkey of the genus *Cercopithecus*, with a List of the known Species," *Proc. Zool. Soc.* 1893, p. 243; see also p. 441.

2 *Proc. Zool. Soc.* 1879, p. 451.

The first with which we shall deal is *Colobus*, containing the Monkeys known as Guerezas. These creatures are entirely confined to the African continent, and they are arboreal in habit. It has been attempted to show that their affinities are more with the Platyrrhines than with the group in which they are really to be placed. In favour of regarding them as nearer akin to the American monkeys are only two facts of importance: the first is the practical absence of the thumb, which of course recalls the

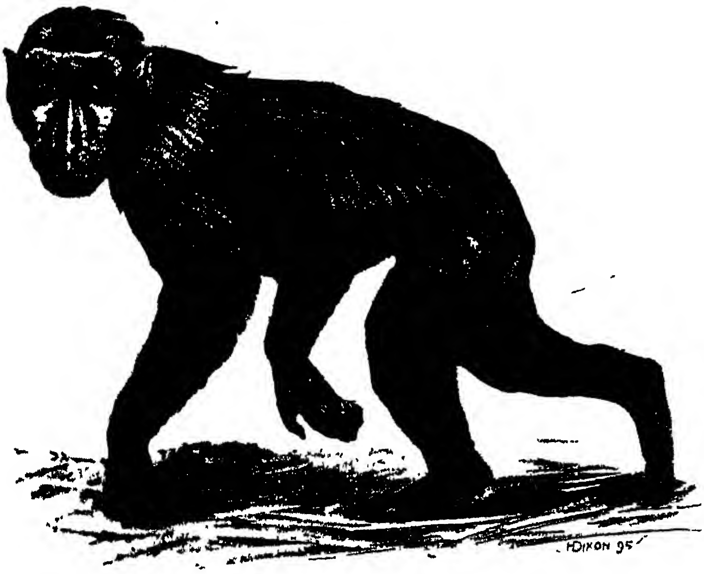


FIG. 270.—Black Celebesian Ape. *Cynopithecus niger*. × ⅙.

condition characteristic of *Ateles*; in the second place, the nostrils in their wideness somewhat resemble those of the Platyrrhines. They are slender Monkeys with well-marked callosities. They have a complex sacculated stomach, resembling the large intestine of some other animals; it is not divided into distinct chambers like the stomach of a Ruminant or of a Whale. Correlated apparently with this large stomach is the small development of the cheek pouches. This genus, of which there are about ten species, is characterised by beautiful skins, which are largely collected. The Arabs have a legend to the effect that one species, when wounded, and seeing its capture and the removal of its skin

inevitable, carefully tears the latter, that its captors may not profit by it. The species of this genus are most abundant on the west coast of Africa. It is interesting that one species, *C. kirki*, is limited to the Island of Zanzibar, where, however, it is nearly extinct.

The "Holy Apes," or Langurs, genus *Semnopithecus*, are allied to the last, but they are Asiatic in range. The thumb is better developed, but still shorter than in other Cercopithecidae; the callosities are small, and the cheek pouches are absent. There is a single large laryngeal sac, and the stomach is complex.

This genus is, like the Tiger, often quoted as an example of a race supposed to be characteristically tropical, existing habitually in the coldest climate. A species of *Semnopithecus* has been observed climbing snow-laden branches at a height of 11,000 feet in the Himalayas. There are some thirty species, which extend as far east as Borneo.

The name *Semnopithecus* is derived from the fact that the Hanuman is regarded as sacred by the Hindus. The best-

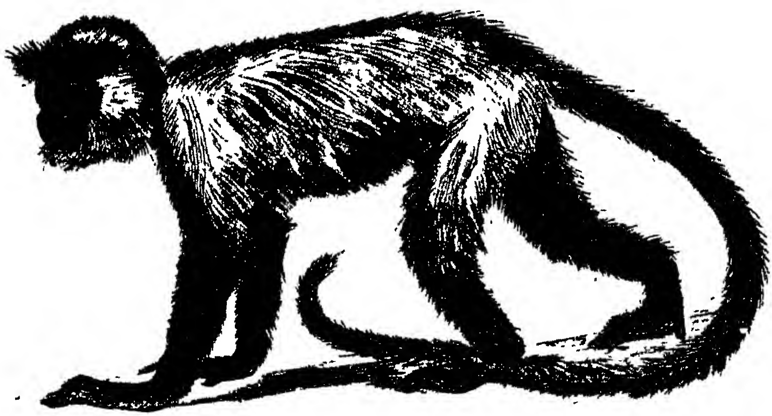


Fig. 271.—Entellus Monkey or Hanuman. *Semnopithecus entellus*. × ⅛.

known species of *Semnopithecus* is this Langur or Hanuman, *S. entellus*. Being regarded as a sacred animal, and with the advantage thus gained, it has become a fell nuisance in gardens and to crops. Though the veneration with which the Hindoos regard these animals will not allow them to slay them, they are exceedingly thankful to a European who will enable them to

commit a sin vicariously. This Ape has immense powers of leaping—a space of 20 to 30 feet can be cleared by them if one side, that from which the leap is taken, be considerably higher than the other. They are useful to the Tiger hunter, as they follow and hoot at this, their deadly enemy. *S. schistaceus* is a species which lives at great heights, not less than 5000 feet, in the Himalayas.

The genus *Nasalis* is hardly separable from the genus *Semnopithecus.* It is a Bornean animal, and is distinguished by a comical long nose, which not only suggests, but goes beyond, the aquiline nose of the human species. It is no doubt on this account that the Borneans, unconsciously imitating our habit of comparing "natives" in general to Monkeys, call it by a name which signifies "white man." *Rhinopithecus* has also a long, but a more definitely upturned nose.

Fossil Monkeys.—Several of the existing genera of Old-World Apes are also known to have existed in past times; in some cases their past distribution indicates a greater range. Thus *Macacus* is now represented—and that doubtfully—in Europe by the Barbary Ape alone. But from Montpellier have been unearthed the remains of *M. priscus,* from Pliocene beds. The Asiatic *Semnopithecus* is known to have lived during the Pliocene period; its remains are discovered in France and Italy, as well as in Asia. In addition to these existing forms, a number of totally extinct Old-World genera are known. The rich formation at Pikermi near Athens has produced *Mesopithecus pentelici;* this Monkey has a skull which recalls that of *Semnopithecus,* while the stout limbs are rather Macaque-like. As is the case with many living Catarrhines, the males have stronger canines. The animal had a long tail.

An analogous annectent character is shown by the Italian fossil, *Oreopithecus bambolii.* This animal was referred by one palaeontologist to the Man-like Apes, by another to the Cercopithecidae. It suggests a common ancestral form, and is Middle Miocene in horizon.

Just as there are no Platyrrhine Apes in the Old World so there are no Catarrhines met with in a fossil condition in the New World; the two great divisions of the Apes were as distinct in the past, so far as we know, as they are now—a strong argument in favour of those who would derive them from two sources. The

existing genera, *Cebus, Mycetes,* and *Callithrix,* now living in South America, are also known in a fossil state. The extinct genus *Homunculus* is known from the Tertiary strata of Patagonia, and an apparently allied form is *Anthropops.* These creatures, however, are at present far from exhaustively known.

Fam. 2. Simiidae.—The Anthropoid, or Man-like Apes,[1] may be separated from the lower Apes as a group, Simiae, or perhaps better, on account of the after all slender points of difference, a family Simiidae, which has the following distinctive characters.

Though arboreal creatures for the most part, these Apes, when they come to the ground, progress in at least a semi-erect fashion. Moreover, when they, as is usually the case, put their hands upon the ground to aid in walking, they do not rest as do the lower Apes upon the flat of the hand, but upon the back of the fingers. None of the Anthropoids has a tail, or cheek pouches. Ischial callosities are only seen in the Gibbons. There is commonly a laryngeal pouch, which is of large size, and aids in the production of the generally loud voice of these creatures. The hair is rather more scanty than in the Cercopithecidae, which is an approach to Man. The placenta differs in detail from that of the lower Apes, and is exactly like that of Man. These Apes show as further differences from the underlying Cercopithecidae, the greater length of the arms as compared with the legs, and the presence of a vermiform appendix to the caecum. In the latter but not the former character they agree with Man, whom we shall place in a separate family, Hominidae. The Anthropoid Apes are entirely Old World and intratropical in range at the present time.

The Gibbons, genus *Hylobates,* stand quite at the base of the series of existing Anthropoid Apes. They are the smallest and the most purely tree-frequenting of all the members of that group. Connected with this habit is the structural peculiarity that their arms are proportionately longer than in the other Anthropoids. The affinity of the Gibbons to the Catarrhines is proved by the presence of distinct but small ischial callosities. The arms are so long that when walking upright the hands reach the ground. The hallux is well developed. The ribs are thirteen pairs. In the skull the chief noteworthy character as

[1] See the books quoted on p. 576 (footnote).

compared with other Anthropoids is the fact of the large size of the canines, which are of equal or nearly equal size in the two sexes. The molars on the other hand have been particularly

FIG. 272.—Hoolock. *Hylobates hoolock.* × ⅙.

compared to those of Man. The brain is simpler than in the higher forms. But it is not clear that this may not be a case of diminished complexity of convolution going hand in hand with smallness of size.

The Gibbons range through south-eastern Asia from Assam and Burmah to Hainan. The number of species is a little doubtful. It is clear that in the first place we may distinguish the Siamang, *H. syndactylus*, which indeed some regard as a separate genus. It is mainly to be defined by the syndactylous character of the second and third toes; they are united by skin as far as the last joint. The Hainan species, *H. hainanus*, is probably distinct, and the following names have been given to various other species or races, viz. *H. agilis, H. leuciscus, H. leucogenys, H. lar, H. hoolock.* These animals can walk erect; and when they do so, the big toe is separated as in unsophisticated or at least unbooted man. The voice is well known to be loud,

and it is a curious fact that the Siamang, which has a large laryngeal pouch, is not excelled in this respect by species in which this sac is not developed.

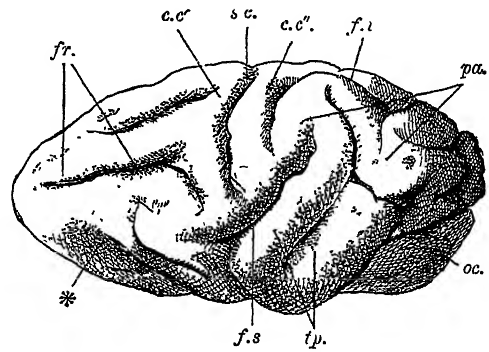


FIG. 273.—Cerebrum of the Gibbon (*Hylobates*). (Lateral aspect.) *c c'*, *c.c''*, Anterior and posterior central convolution; *fi*, interparietal fissure; *fr*, frontal lobe; *f.s*, Sylvian fissure; *oc*, occipital lobe; *pa*, parietal lobe; *s.c*, fissure of Rolando; *tp*, temporal lobe; *, fronto-orbital fissure. (From Wiedersheim's *Structure of Man.*)

Of Gorillas, genus *Gorilla,* there is but one species, which must apparently and rather unfortunately be called *Gorilla gorilla.*

The misfortune is double: in the first place the repetition of the same word as both generic and specific appellation is tiresome to the ears and barbarous in its suggestion; in the second place it is now well known that the "Gorilla" of Hanno, observed by that Carthaginian voyager on an island off the African coast, was not a Gorilla at all as the word is now understood, but probably a Baboon. The external aspect of this great Anthropoid is familiar from many reproductions. The male, as is usual, is larger than the female, and his characters are more pronounced.

The face is naked and black, and the skin generally is deep black, even at birth. The ear is comparatively small, and is adpressed to the side of the head; it is altogether more human in form than that of the Chimpanzee, and this statement applies also to the rudimentary condition of the muscles of the ear, which are more rudimentary than in the Chimpanzee. The nose has an obvious median ridge, and is thus pronounced as an external feature; the nostrils are very wide. The hands and feet are short, thick, and broad; the digits are webbed. In the foot the heel is more apparent than in other Anthropoids. It is not,

however, so marked as in Man, and the phrase "Ex pede Herculem" has been aptly supplemented by "Ex calce hominem." The hair upon the head forms a kind of crest, which can be elevated when the animal is enraged. The neck is thick and short, and the beast has massive shoulders and a broad chest.

If it were not for the fewness of the Anthropoid Apes, and their nearness to Man, it is doubtful whether the Gorilla would be ranked as a distinct genus,[1] for in internal structure it is

FIG. 274.—Gorilla. *Gorilla gorilla*, ♀. ×⅛.

very near the Chimpanzee. The microscopic character of the investigations into the anatomy of Man have somewhat dimmed the proper sense of perspective, and have tended to throw into greater prominence than seems necessary the divergences of structure seen in the Gorilla. Dr. Keith[2] has recently summed up and commented upon these divergences, and the following account of this Anthropoid is mainly deduced from his memoir.

The cranial capacity of the Gorilla is greater than that of the Chimpanzee. It is not possible, however, to decide from this point of view whether a given skull is that of one or of the other of these Apes. Some Chimpanzees are higher in capacity

[1] It is not so ranked by everybody. [2] *Proc. Zool. Soc.* 1899, p. 296.

than some Gorillas. But the average is undoubtedly as stated. It is to be noted that there is a correspondence between cranial capacity and size of palate, the correspondence being converse, *i.e.* the greater the brain the smaller the palate. This applies to Man as compared with his Ape-like relatives, but does not apply so accurately to the Gorilla, which has a more extensive palate than the Chimpanzee; its "brute development" is much greater than that of the Chimpanzee. Not only is the palate larger, but the molar teeth, slightly different in form, are also larger and stronger. This is so plainly marked that "one may say almost with certainty, that any upper molar tooth over 12 mm. in length is that of a Gorilla, and under 12 mm. is that of a Chimpanzee." In the skeleton generally it may be said that the crests for muscular attachments upon the bones are greater in the Gorilla. The nasal bones are more like those of lower Apes in their length, and they have a sharp ridge more marked than in the Chimpanzee, which, however, disappears in aged animals. It is a curious fact that Gorillas often have a "cleft palate," owing to the failure of the palatal part of the palatine bones to meet completely. The general conformation of the skull is less brachycephalic in the Gorilla.

The limbs show a number of small differences, which are associated with a more completely arboreal life in the Chimpanzee as compared with the Gorilla. The latter is approaching the human way of life. In spite, however, of these differences, no hard and fast lines of divergence can be laid down between the two African Anthropoids, for it appears from the many memoirs that have been written upon both that "there is scarcely a feature in any muscle or bone found in one animal which is not also found in the other." The heel of the Gorilla has already been referred to. This is, of course, associated with a plantigrade and therefore non-arboreal mode of progression. Certain of the muscles of the calf of the leg attached to the heel show a more human arrangement in the Gorilla than in the Chimpanzee. It is interesting to find that the muscles of the little toe are diminishing in the Gorilla as in Man. This is most clearly due to terrestrial progression and we may apply the same explanation to Man and ignore tight boots! The arm of the Gorilla is less adapted to arboreal progression. Its proportions differ from those of the arm of the Chimpanzee in that the fore-arm is shorter. In

both animals the thumb is not of much use, and this digit is more retrograde in the Gorilla, not only in proportionate length but in its muscular supply. The hip girdle tells the same tale. It is broader in the Gorilla, and the glutaei muscles are more prominent, all these features being connected with the more erect gait.

The brain of both animals have been studied, but not in the case of the Gorilla from a sufficiently large number of examples to make any generalisations of great value. On the whole, the Gorilla has the larger brain, but this must be discounted by the fact that it also has the larger body. It is a remarkable fact that the Gorilla's liver is much more like that of lower Apes than the liver of other Anthropoids. It has, as has the Chimpanzee, laryngeal sacs. The general conclusion concerning the relative position of the two African Anthropoids seems to be that the Gorilla is the more primitive, and as thus it must approach more nearly to the original parent than does the Chimpanzee, it may be said that it also comes rather nearer to Man, since the Chimpanzee has travelled away from the common stock on another line. The detailed likenesses to Man, however, are not to be unduly dwelt upon; for they mainly come from a tendency to assume the plantigrade mode of progression.

In mental characteristics there is the widest difference between the two Apes that we are considering. The Chimpanzee is lively, and—at least when young—teachable and tameable. The Gorilla, on the other hand, is gloomy and ferocious, and quite untameable. When angry the Gorilla beats its breast, a statement that was originally made, we believe, by M. du Chaillu, but which has been disputed, though it appears to be perfectly true. A young Gorilla, exhibited some time since in the Gardens of the Zoological Society, could be observed to do so. The cry of the Chimpanzee is different from the "howl" of the Gorilla. An immense amount has been written upon the ways of this animal in its own home, including much that is legendary. The Gorilla has been said to lurk in the depths of the forest, and to stretch down a prehensile foot to grasp and strangle an unfortunate black man passing below. It is said, too, to vanquish the Elephant by hitting it hard upon the trunk with a stout stick, and to crumple up the barrel of a rifle with its powerful teeth.

Apart from the doubtful "Pongo" and "Engeco" of Andrew Battel, our first intelligence concerning the Gorilla is due to Dr. Savage, after whom, indeed, the late Sir Richard Owen called the animal *Troglodytes savagei*, a name which has to be abandoned in favour of an earlier name.

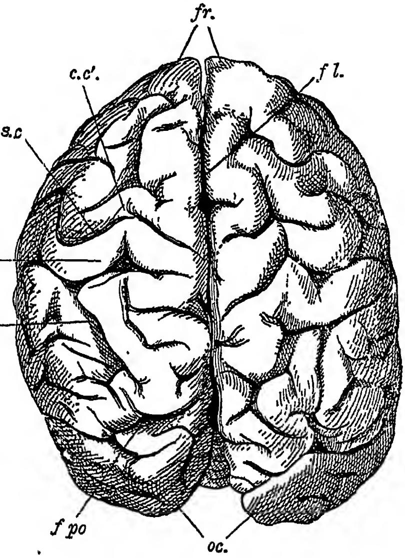
The Gorilla is limited in its distribution to the forest tract of the Gaboon. It goes about in families, with but one adult male, who later has to dispute his position as leader of the band with another male, whom he kills or drives away, or by whom he is killed or driven away. The animal is said to make a nest in a tree like the Orang; but this statement has been questioned.

It feeds upon the berries of various plants, and upon other vegetable substances; there is apparently not so marked an inclination for animal food as is exhibited by the Chimpanzee. In search of their food they wander through the forest, walking partly upon the bent hand, and progressing with a shuffling gait. It is noteworthy that the Gorilla has been said to walk upon the palm of the hand and not upon the back, as is the case with the Chimpanzee. It can readily assume the upright posture, and, in this case, balances itself largely with its arms. Professor Hartmann, however, states that the back of the hand is also used. Unlike most or many wild beasts, the Gorilla exhibits no desire to run away when he views a human enemy. Dr. Savage remarks that "when the male is first seen, he gives a terrific yell, that resounds far and wide through the forest, something like kh-ah! kh-ah! prolonged and shrill." This is accompanied by offensive tactics, which the natives do not willingly encounter. When making an attack the Gorilla rises to his feet, and as a full-grown animal reaches a height of some five feet, he is a most formidable antagonist. The attack of one of these animals is said to be made with the hand, with which he strikes his adversary to the ground, and then uses the powerful canines. The beating of the breast which heralds an attack is a statement made by M. du Chaillu. It has been denied with a vigour and asperity quite incommensurate with the importance of the matter.[1]

The Chimpanzees, genus *Anthropopithecus* (or *Troglodytes*), are

[1] For accounts of the habits of the Gorilla, compiled from various sources, see Hartmann's "Anthropoid Apes," *International Scient. Ser.* London, 1885; H. O. Forbes, "Monkeys," in Allen's *Naturalists' Series*, London, 1894; and Huxley, "Man's Place in Nature," vol. vii. of *Collected Essays*, London, 1894.

to be distinguished from the Gorilla by the characters mentioned in the account of the latter animal. Briefly summed up they,



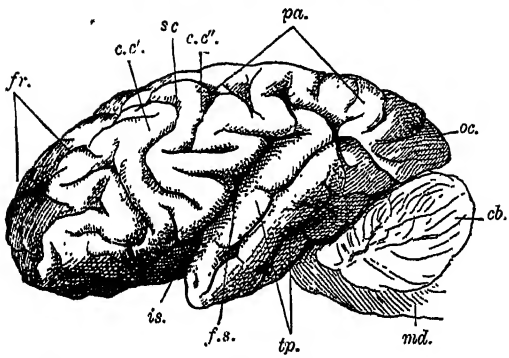


FIG. 275.—A, Cerebrum of a female Chimpanzee two years old. × ½. (Dorsal aspect, showing asymmetrical development.) *c.c'*, *c.c"*, Anterior and posterior central convolutions; *f.i*, interparietal fissure; *f.l*, the longitudinal fissure; *f.po*, parieto-occipital fissure; *fr*, frontal lobes; *oc*, occipital lobes; *s.c*, sulcus centralis. B, Brain of a female Chimpanzee two years old. × ½. (Lateral aspect.) *cb*, Cerebellum; *c.c'*, *c.c"*, anterior and posterior central convolutions; *fr*, frontal lobe; *f.s*, fissura Sylvii; *is*, island of Reil; *md*, medulla oblongata; *oc*, occipital lobe; *pa*, parietal lobe; *s.c*, sulcus centralis; *tp*, temporal lobe. (From Wiedersheim's *Structure of Man*.)

are mainly as follows:—The ears are large, and generally stand out from the head; but there are exceptions to be noted pre-

sently. The pigmentation of the body is not always so pronounced as in the Gorilla. The nasal bones are shorter. The skull as a whole is more brachycephalic, and the molar teeth are smaller. The hands and feet are much longer, the animal being more purely arboreal than the Gorilla. The female Chimpanzee is slightly smaller than the male, but the great disparity observable in the Gorilla does not characterise its ally. The animal, like the Gorilla, has large air sacs.

Chimpanzees are entirely restricted to Africa, and though

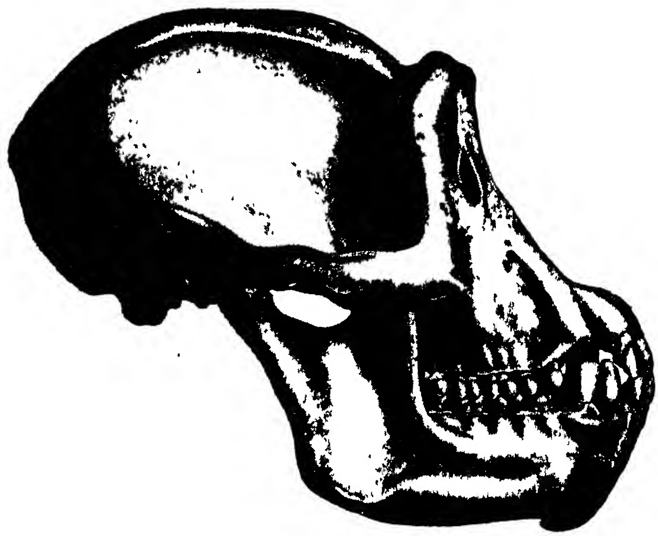


FIG. 276.—Skull of Chimpanzee. *Anthropopithecus troglodytes.* × ⅓. (After de Blainville.)

they appear to extend rather farther east than the Gorilla, the forest-clad region of the equatorial belt is their home.

It has been mentioned in treating of the Gorilla that the main feature of this animal, which affords a constant difference from the Chimpanzee, is its gloomy and ferocious manner. The Chimpanzee, on the other hand, is lively and playful, though often maliciously so, and quite tameable, as many instances—particularly the notorious "Sally" of the Zoological Gardens—show. The earliest mention of animals that are probably Chimpanzees is to be found in a work upon the Kingdom of Congo, published in 1598. In a cut illustrating that work, and of

which a part is reproduced in Professor Huxley's essay referred to below,[1] the Apes, which correspond roughly in their appearance to Chimpanzees, are represented as being captured by the device of limed boots, which the Apes are putting on. This idea has been subsequently imitated and acted upon. A little later, Andrew Battel wrote of the Pongo and of another creature the Engeco. This latter, whatever may be the case with the former, is in all probability the Chimpanzee, since the word 'Nchego, now applied to those creatures, seems to be the same word. From this seems also to be derived the sailor's term "Jacko." Whether there are or are not more than one species of Chimpanzee, is a matter which has exercised and perplexed naturalists. That there are plain differences of external features, at any rate between individuals, is perfectly clear. We are justified in recognising three forms, but the question of their specific distinctness may for the present be held in reserve. The commonest of these is the variety known as *A. troglodytes.* This is frequent in menageries, though the specimens on view are nearly always young and small. The face and the hands are flesh-coloured, and the ears are very large. The black hair gets a reddish tinge on the flanks. The second variety is that which was termed by du Chaillu *Troglodytes kooloo-kamba.* This animal appears to be also the *T. aubryi* of MM. Gratiolet and Alix,[2] and to be identical with two Apes known by the names of "Mafuca" and "Johanna."[3] The former of these was exhibited in Dresden, the latter at Messrs. Barnum and Bailey's show. The two animals have been carefully studied. They differ from the common Chimpanzee by the dark colour of the face, and in the case of Mafuca the ear was Gorilline in form. So too was the ear of *A. aubryi,* while Johanna has a larger one. These features have led to the suggestion that the Kooloo-kamba was the result of a mésalliance between a Gorilla and a common Chimpanzee.

It has at any rate been stated that the two Anthropoids do go about in company; but there seems to be little doubt that there is no question here of a hybrid. Dr. Keith's careful studies[4] upon Johanna have demonstrated the impossibility of

[1] "Man's Place in Nature," vol. vii. of *Collected Essays,* London, 1894.

[2] Hartmann's "Anthropoid Apes," in *International Sci. Ser.* London, 1885.

[3] *Nouv. Arch. Mus. Hist. Nat.* Paris, ii. 1866.

[4] *Proc. Zool. Soc.* 1899, p. 296.

regarding this Ape as anything but a Chimpanzee. The animal has the ways and manners of the Chimpanzee; has a cry exactly like that of *A. troglodytes;* does not beat her breast like a Gorilla when annoyed. Anatomical knowledge, however, of this specimen is at present wanting.

Anthropopithecus calvus[1] seems to be at least as much entitled to distinction as the last. It was originally described by du

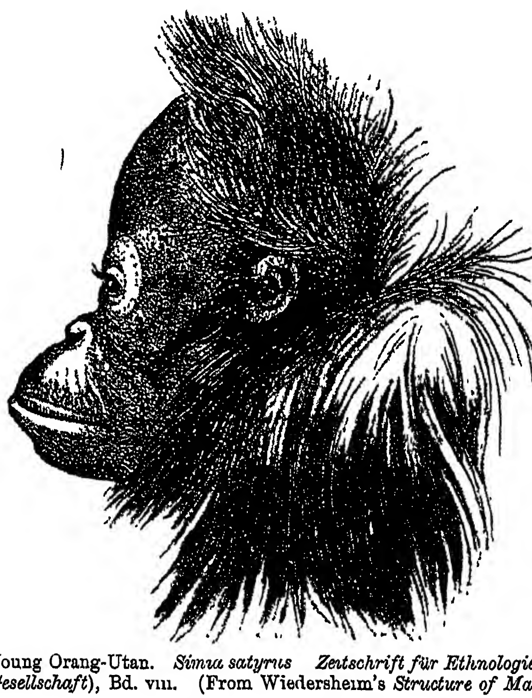


FIG. 277.—Young Orang-Utan. *Simia satyrus* *Zeitschrift für Ethnologie* (*Anthropolog. Gesellschaft*), Bd. VIII. (From Wiedersheim's *Structure of Man.*)

Chaillu; but Dr. Gray who examined the skins thought that the baldness was accidental, and then after this wise caution proceeded to describe, under the name of *A. vellerosus,* perhaps the "worst" species of Chimpanzee that has been added to the unnecessarily long list of "species" of Chimpanzees. To this variety belonged "Sally"[2] of the Zoo, whose intelligence has been celebrated by the late Dr. Romanes. The form is characterised

[1] See also Duckworth, *Proc. Zool. Soc.* 1898, p. 989.

[2] For the structure of this Ape see Beddard, *Trans. Zool. Soc.* xiii. 1893, p. 177; and for experiments on her intelligence, Romanes, *Proc. Zool. Soc.* 1889, p. 316.

by its intense blackness, the red reflection of other Chimpanzees not being visible; also by the bald head, whence of course the name. The nostrils of this Ape, as of Johanna, were somewhat expanded, and thus present a certain likeness to the Gorilla. But there can be no suggestion that *A. calvus* is the product of a union between the two African Anthropoids. As is

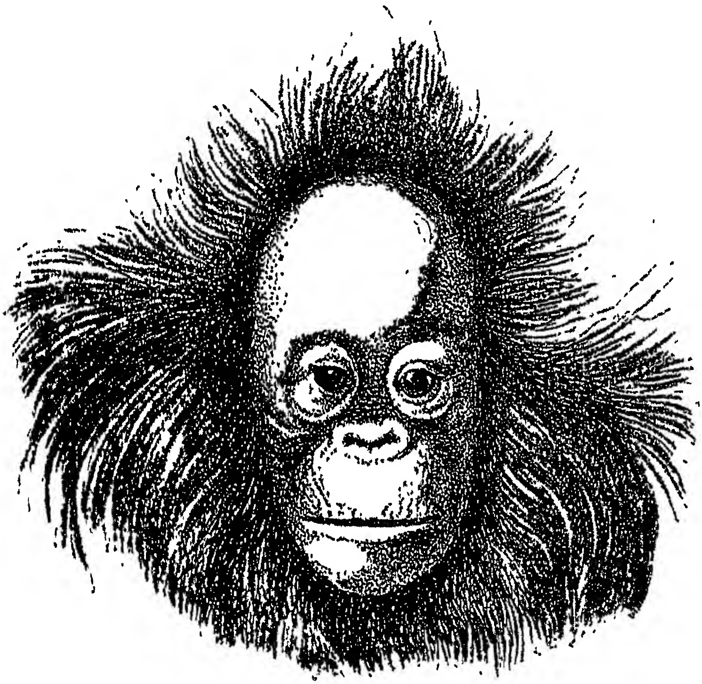


FIG. 278.—Young Orang-Utan. *Simia satyrus*. *Zeitschrift fur Ethnologie* (*Anthropolog. Gesellschaft*), Bd. viii. (From Wiedersheim's *Structure of Man.*)

the case with Johanna, Sally was given and enjoyed animal food on occasions. It is a curious fact that both Sally and Johanna appear to have been colour-blind.

The Orang Utan, genus *Simia*, has but one definable species, viz. *S. satyrus*. The supposed species of Owen, *S. morio*, cannot be satisfactorily defined. Plenty of other specific names have also been given to what is in all probability but a single species of large Anthropoid Ape inhabiting the islands of Borneo and Sumatra.

The name Orang-Utan, now applied exclusively to the subject of the present description, was formerly applied also to the Chimpanzee, and to that animal, moreover, under the latinised version of *Homo sylvestris*. The Orang is a large and heavy Ape with a particularly protuberant belly and a melancholy expression. The face of the old male is broadened by a kind of callous expansion of naked skin at the sides. The colour of the animal is a

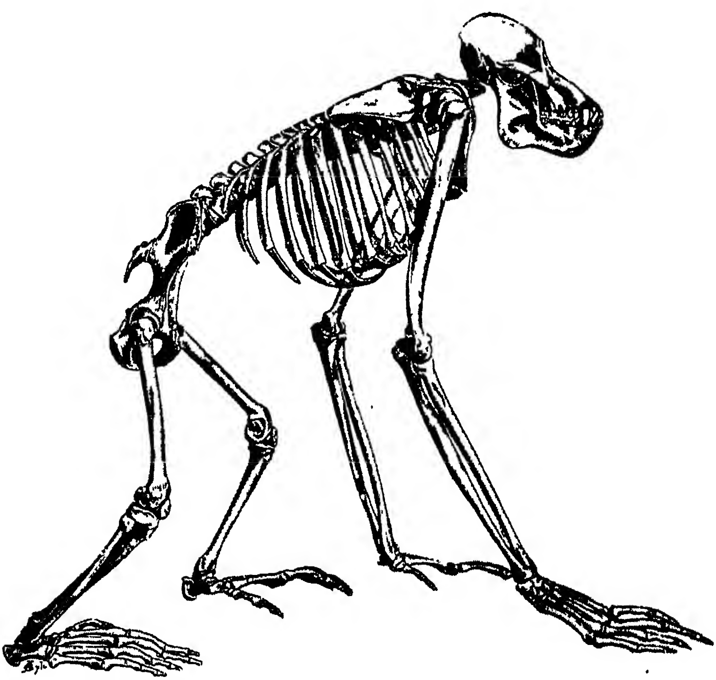


FIG. 279 —Skeleton of Orang *Simia satyrus*. (After de Blainville.)

yellow brown, varying in the exact shade. The ears are particularly small and graceful in appearance, pressed closely to the sides of the head The head is very brachycephalic. The arms are very long, and when the animal is in the erect posture they reach as far as the ankle The hallux is very short and usually destitute of a nail. It is a curious fact that the head of the thigh bone is unattached by a ligament to the socket of the pelvis in which it articulates, a state of affairs which may give the limb greater freedom in movement, but does not add to its strength ;

indeed, the Orang has been described as moving with laborious caution.

This Ape inhabits flat and forest-clad ground, and lives mainly in the trees. The male leads a solitary life except at the pairing season, but the female goes about with her family. On the ground the Orang walks with no great ease, and uses his arms as crutches to swing the body along. Even on trees the rate of progress is not rapid, and is accomplished with careful investigations as to the capabilities of the branches to bear his weight.

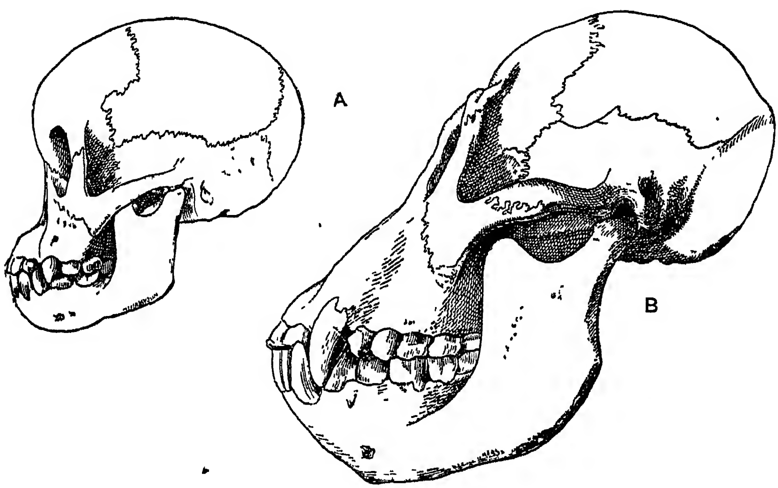


FIG. 280.—A, Skull of a young Orang-Utan. *Simia satyrus*. (One-third natural size.) B, Skull of an adult Orang-Utan. (One-third natural size.) (From Wiedersheim's *Structure of Man.*)

The "Man of the Woods" has been stated to build a hut in trees. This is an exaggeration of the fact that it constructs a temporary nest.

One of these nests has lately been described elaborately by Dr. Moebius. It was found (by Dr. Selenka) on the fork of a tree at a height of 11 metres from the ground. Every night, as it appears, or every second night, the animal constructs a new nest for himself, abandoning the old one. So numerous, therefore, are these nests in localities frequented by Orangs, that a dozen can be readily found in a day. The particular nest which Dr. Moebius examined was 1·42 metres long, and at most ·80 metre broad. It was built of about twenty-five branches, broken off and laid for

the most part parallel to each other. Above this framework a number of loose leaves lay. There is no doubt, therefore, that these nests are not by any means elaborate structures, and that they only serve as sleeping-places, and not as nurseries for the up-bringing of the young, as has been asserted.

The Orang seems to be usually of a fairly mild disposition; it will rarely attack a man unprovoked. But Dr. Wallace, who has accumulated a large number of observations upon these animals, describes a female Orang who "on a durian tree kept up for at least ten minutes a continuous shower of branches, and of the heavy-spined fruits as large as 32-pounders, which most effectually kept us clear of the tree she was on. She could be seen breaking them off and throwing them down with every appearance of rage, uttering at intervals a loud pumping grunt, and evidently meaning mischief." The name given by the Dyaks to the Orang is Mias Pappan.[1]

Fossil Anthropoid Apes.—Undoubtedly the most interesting of fossil Anthropoids is the now famous *Pithecanthropus erectus*. Our knowledge of it is due in the first place to Dubois.[2] But there is hardly an anatomist or an anthropologist who has not had his say upon this regrettably very incomplete remnant. The creature is only known by a calvarium, two separate teeth, and a femur. And the femur, moreover, is diseased. M. Dubois discovered these remains in the island of Java in andesite tufa of Pliocene or at least early Pleistocene age. The remains were found in company with *Stegodon*, which is now extinct, and *Hippopotamus*, which is no longer found in that part of the world. The name *Pithecanthropus* was given to it by the discoverer in order to furnish with a definite habitation and a name the theoretical *Pithecanthropus* of Haeckel. Even the most particular of students of mammalian nomenclature will hardly object to the utilisation of a name for a second time which is with some clearness a *nomen nudum!* The animal when erect must have stood 5 feet 6 inches high. The contents of the cranium must have been 1000 cm., that is to say 400 cm. more than the cranial capacity of any Anthropoid

[1] For the external appearance of the Orang see Hermes, *Zeitschr. f. Ethn.* 1876, a paper which has coloured plates.

[2] *Pithecanthropus erectus. Eine menschenähnliche Uebergangsform aus Java*, Batavia, 1894. See also Ernst Haeckel, *The Last Link* (with notes by H. Gadow), London, 1898; Manouvrier, *Amer. Journ. Sci* 1897, p. 213 (extracts); and Klaatsch, *Zoolog Centralbl.* vi. 1899, p. 217.

Ape, and quite as great as or even a trifle greater than the cranial capacity of some female Australians and Veddahs. But as these latter are not 5 feet in height, the Ape-like man had really a less capacious cerebral cavity. The skull in its profile outline stands roughly midway between that of a young Chimpanzee (young in order to do away with the secondary modifications caused by the crest) and the lowest human skull, that of Neanderthal Man. This creature is truly, as Professor Haeckel put it, "the long searched for 'missing link,'" in other words represents "the commencement of humanity."

The remains of Apes, more distinctly Apes than *Pithecanthropus*, are known from Miocene strata of France. Two genera, *Pliopithecus* and *Dryopithecus*, are known. The former appears to be close to *Hylobates*. *Dryopithecus* is more Man-like than any other, and seems to have been as large as a Chimpanzee. The incisors are human in their relatively small size. But it has been pointed out that the long and narrow symphysis of the lower jaw is a point of likeness to the Cercopithecidae.

Fam. 3. Hominidae.—Apart from *Pithecanthropus*, which perhaps is a member of this family, but whose remains permit us to leave it among the Simiidae, at least for the present, the family Hominidae contains but one genus, *Homo*, and probably but one species, *H. sapiens*. The characters of the family may therefore be merged in those of the genus.[1]

Though it is easy enough to distinguish a Man from an Ape, it is by no means easy to find absolutely distinctive characters which are other than "relative." As Professor Haeckel has pointed out, there are really only four characters which differentiate Man: these are the erect walk, and the consequent modification of the fore- and hind-limbs to that position; the existence of articulate speech; the faculty of reason. Whether one body of psychologists are right who argue that reason is a distinctive human attribute, not to be confused with the apparent reasoning powers of lower animals, or whether others are justified in separating Man only in degree from the lower animals, it is clear that this very diversity of opinion prevents us for the present from utilising such characters as absolute differences. In any case the discussion of these matters is beyond the scope of the present book.

[1] See especially Wiedersheim, *The Structure of Man*, transl. by Howes, London, 1895.

Anatomically there are a number of small points which distinguish Man; but they are mainly due to the erect gait. It is sometimes attempted to divide Man as a naked animal. But this is an apparent difference only; thé hair is not so much developed upon the body as in the Apes, save in occasional abnormalities, such as

FIG. 281.—Skull of Immanuel Kant. (After C. von Kupffer.) The great size of the cranium is a noteworthy feature. (From Wiedersheim's *Structure of Man.*)

the various hairy men and women who can be seen in travelling shows, and to a less extent the Japanese Ainos, but it is present everywhere, as is shown by microscopical investigation of the skin. The skull in Man "is a smooth and imposing, rounded or oval bony case," which contrasts with the smaller and deeply ridged skull of the Anthropoid Apes. The shape of the skull is largely in accord with the large brain. The face does not project so much as in the Anthropoid Apes, though this character must not

be insisted upon too strongly, as in some American Monkeys the face is as little projecting. Still we are now comparing Man with his undoubtedly nearest relatives the Simiidae. In the lower jaw the anterior line at the symphysis is an approximately straight one, that is at right angles to the long axis of the jaw, while Apes have a more retreating chin. The "beautiful sigmoid curve formed by the lumbar and dorsal vertebrae" is more pronounced

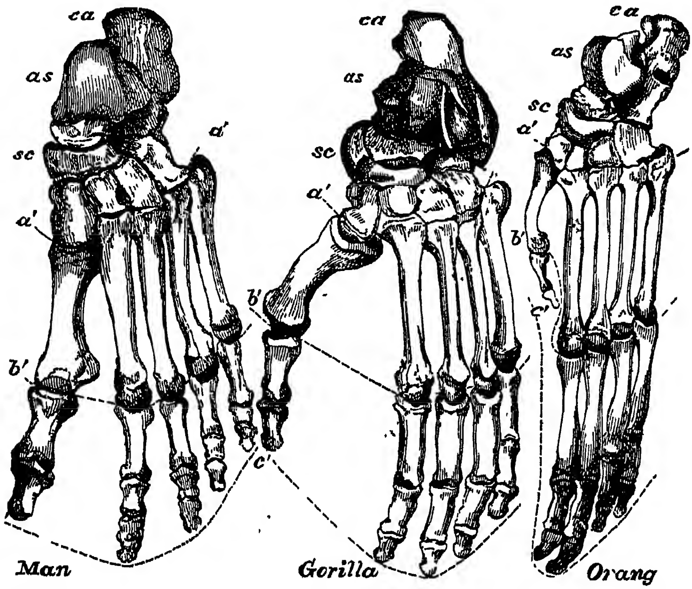


FIG. 282.—Foot of Man, Gorilla, and Orang of the same absolute length, to show the difference in proportions. The line *a'a'* indicates the boundary between the tarsus and metatarsus; *b'b'*, that between the latter and the proximal phalanges; and *c'c'* bounds the ends of the distal phalanges *as*, Astragalus; *ca*, calcaneum; *sc*, scaphoid. (After Huxley.)

in Man, but exists not only in the Anthropoids, but in other Apes.[1]

The fore-limbs are relatively short, the extreme length of the arm being such that the outstretched hand does not reach the knee. The thumb is a large and useful digit in Man, much more so than in the Anthropoids. On the other hand the hallux is not opposable. This is, of course, correlated with the upright attitude, as is also the greater relative thickness of that digit, upon which

[1] Cunningham, "Cunningham Memoirs," No. II. *Royal Irish Acad.* 1886.

the greatest stress is laid in walking. As to muscles, the glutaeus maximus is more developed in Man—the Ape which most nearly approaches him being the Gorilla, in which animal the life is less thoroughly arboreal than in some others. The so-called "scansorius" is only present in Man as an occasional occurrence.

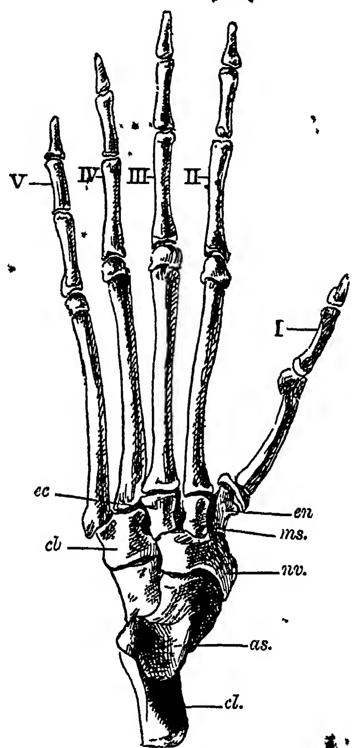


FIG. 283.—Skeleton of the left pes of a Chimpanzee. (Dorsal aspect.) *as*, Astragalus; *cb*, cuboid; *cl*, calcaneum; *ec*, ectocuneiform; *en*, endocuneiform; *ms*, mesocuneiform; *nv*, navicular; *I-V*, digits. (From Wiedersheim's *Structure of Man*.)

The rudimentary character of the ear muscles for the movement of the external ear in Man has often been insisted upon, as also their occasional functional activity. But here and elsewhere, so numerous are the abnormalities, that "the gap which usually separates the muscular system of Man from that of the Anthropoids appears to be completely bridged over." These are words of Professor Wiedersheim quoted from Testut, and express a final summary of the matter of muscles in Man and the Apes.

In his teeth Man differs by the small exaggeration of the

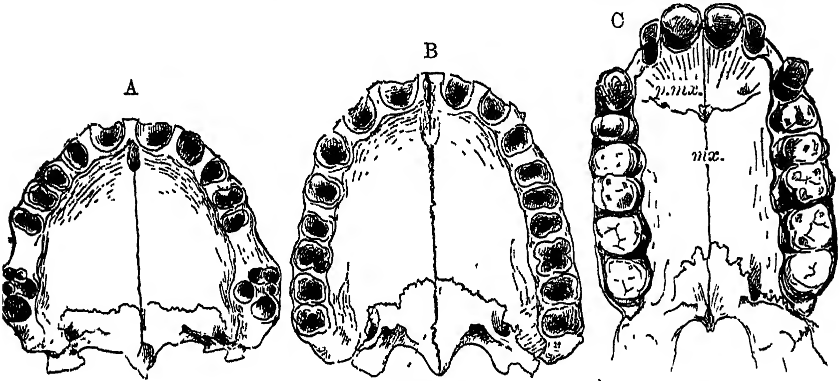


FIG. 284.—The hard palate, A, of a Caucasian, B, of a Negro; C, of an adult Orang-Utan, showing the differences in shape of the bones. The palate of the Negro represents a type transitional between that of the Caucasian and that of the Orang. *mx*, Maxilla; *pl*, palatine; *p.mx*, premaxilla. (From Wiedersheim's *Structure of Man.*)

canines, which hardly, if at all, differ in the two sexes. There is also a complete absence of a diastema. The teeth are also on the whole weaker than in the Anthropoids, though *Hylobates* is very human in this particular.

There is a tendency in Man towards the disappearance of the upper outer incisors, and more markedly still of the wisdom teeth, which appear very late, and are often imperfect. In a large number of cases the tooth does not appear at all. In the larynx there is no great development of the great throat pouches of the Anthropoids. The minute diverticula of that organ, known to human anatomists as the ventricles of Morgagni, alone remain to testify to a former howling apparatus in the ancestors of Man.

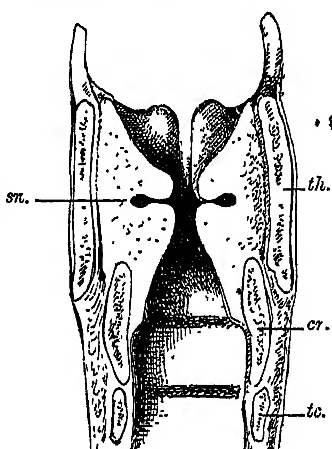


FIG. 285.—Human Larynx in frontal section. *cr*, Cricoid cartilage; *sn*, sinus of Morgagni; *t.c*, first tracheal cartilage; *th*, thyroid cartilage. (From Wiedersheim's *Structure of Man.*)

INDEX

Every reference is to the page: words in italics are names of genera or species; figures in thick type refer to an illustration; f. = and in following page or pages; n. = note.

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